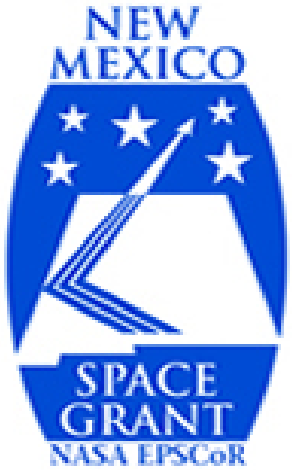
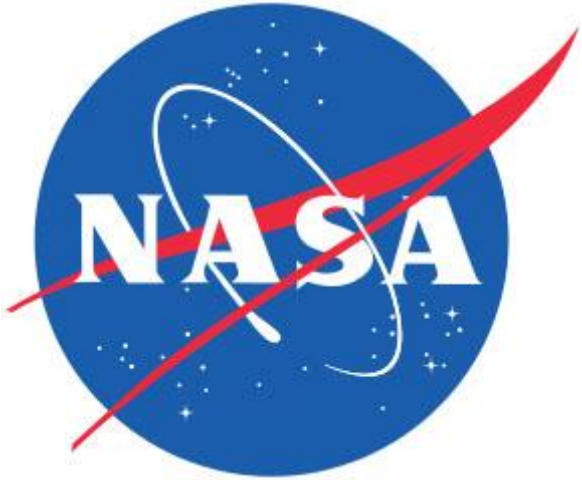
The Geiger Counter Board



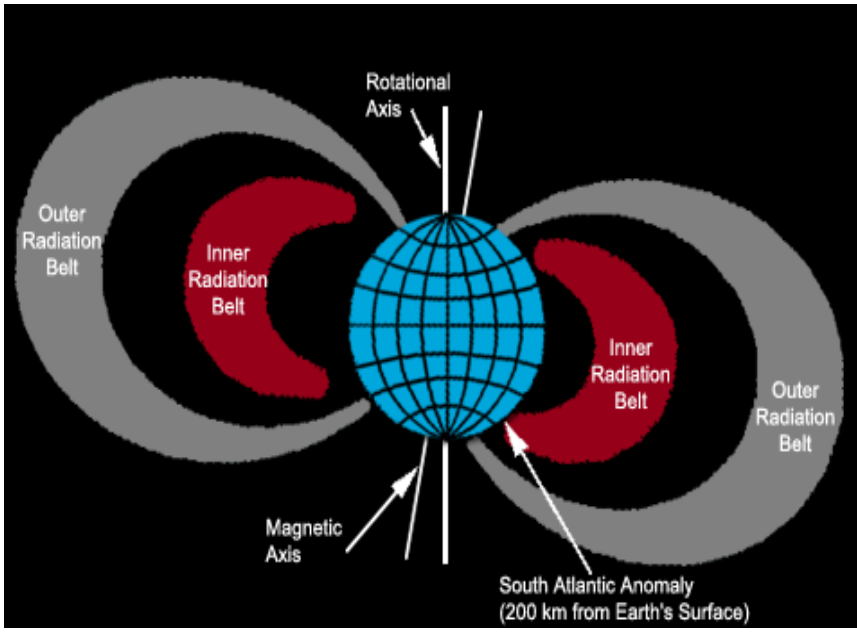


Geiger Counter Background

Arduino IDE Geiger Counter DIY Kit Radiation Logger with LCD and Free Monitoring Software with SD Shield w/ GM Tube

Radiation: Overview

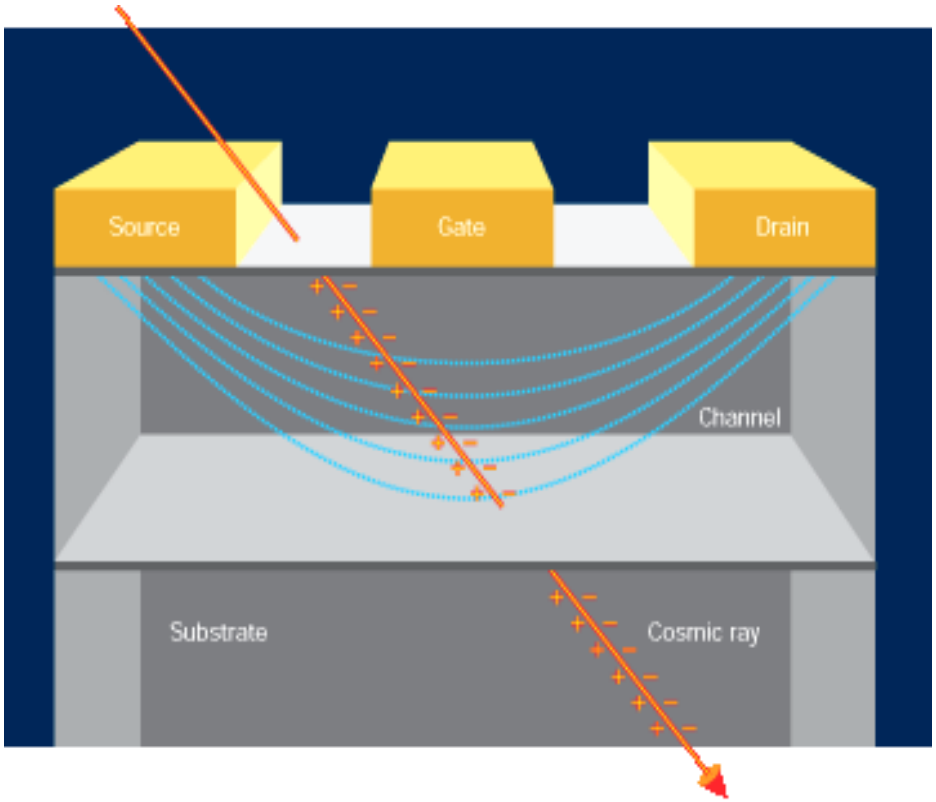
- Radiation is generally viewed as harmful to space payloads.
- While some projects purposely expose parts to the saturated Van Allen belts to investigate the effects of high energy particles, some projects must avoid harmful doses at all costs.
- Sparse data has been collected from suborbital airspace.
- This payload will allow for a large collection of data sets.



Van Allen Belts: www.nasa.gov

Radiation: Effects

- Single event phenomenon (SEP), burnouts and bit flips can cause damage to solid state devices aboard a space payload.
- An understanding of dose levels is ideal to plan a mission to sub-orbital altitudes, especially with sensitive optics or microprocessors.



SEP diagram: www.aero.org/

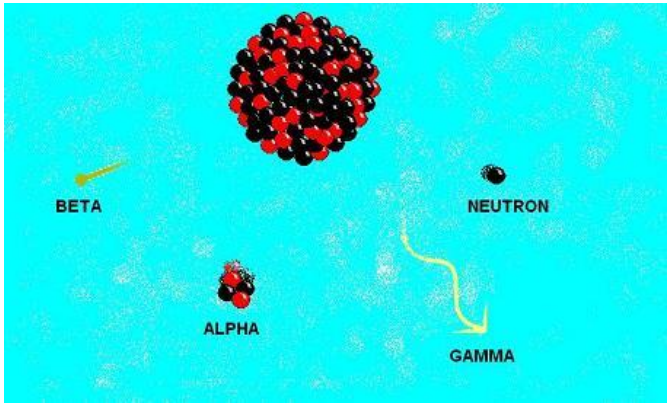
Radiation: Effects

- There are three types of radioactive emissions:

- Alpha - the least penetrating form of radiation, can be stopped with a piece of paper or a few inches of air.

- Beta-rays are more penetrating than alpha-rays

- Gamma-rays are the most penetrating form of radiation. Often produced in conjunction with alpha or beta-rays, they can penetrate several inches of steel or hundreds of feet in air.

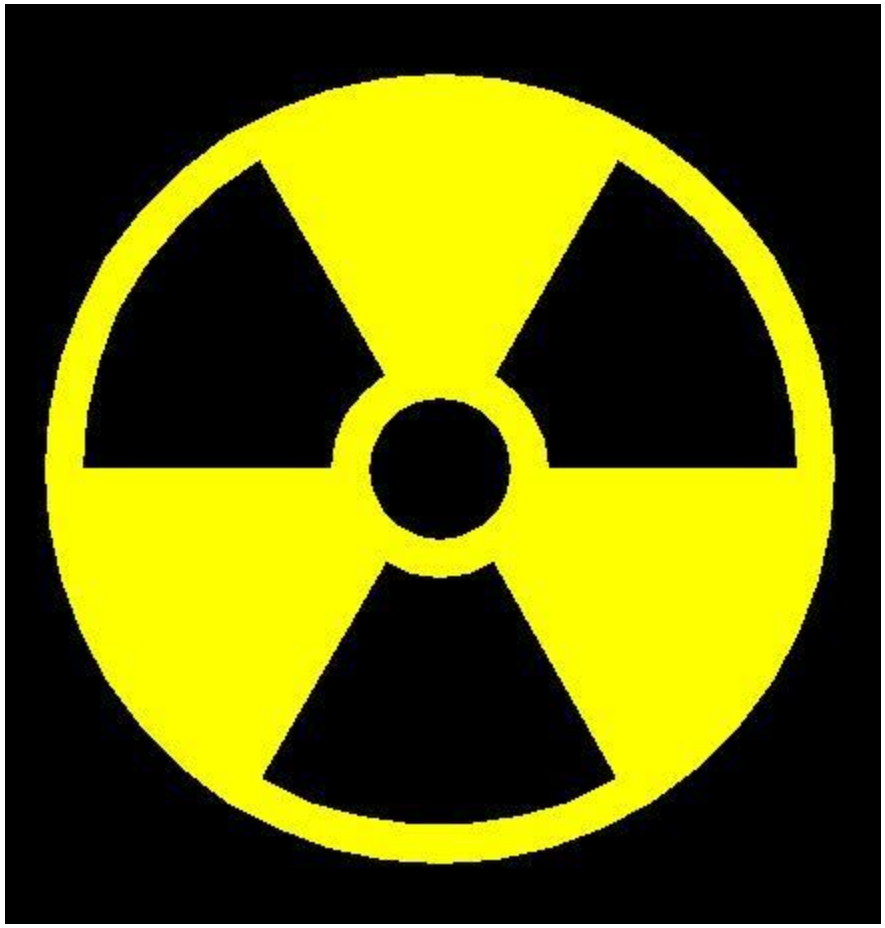


Particle comparison:

www.freedomforfission.org.uk

Radiation: A General Trend

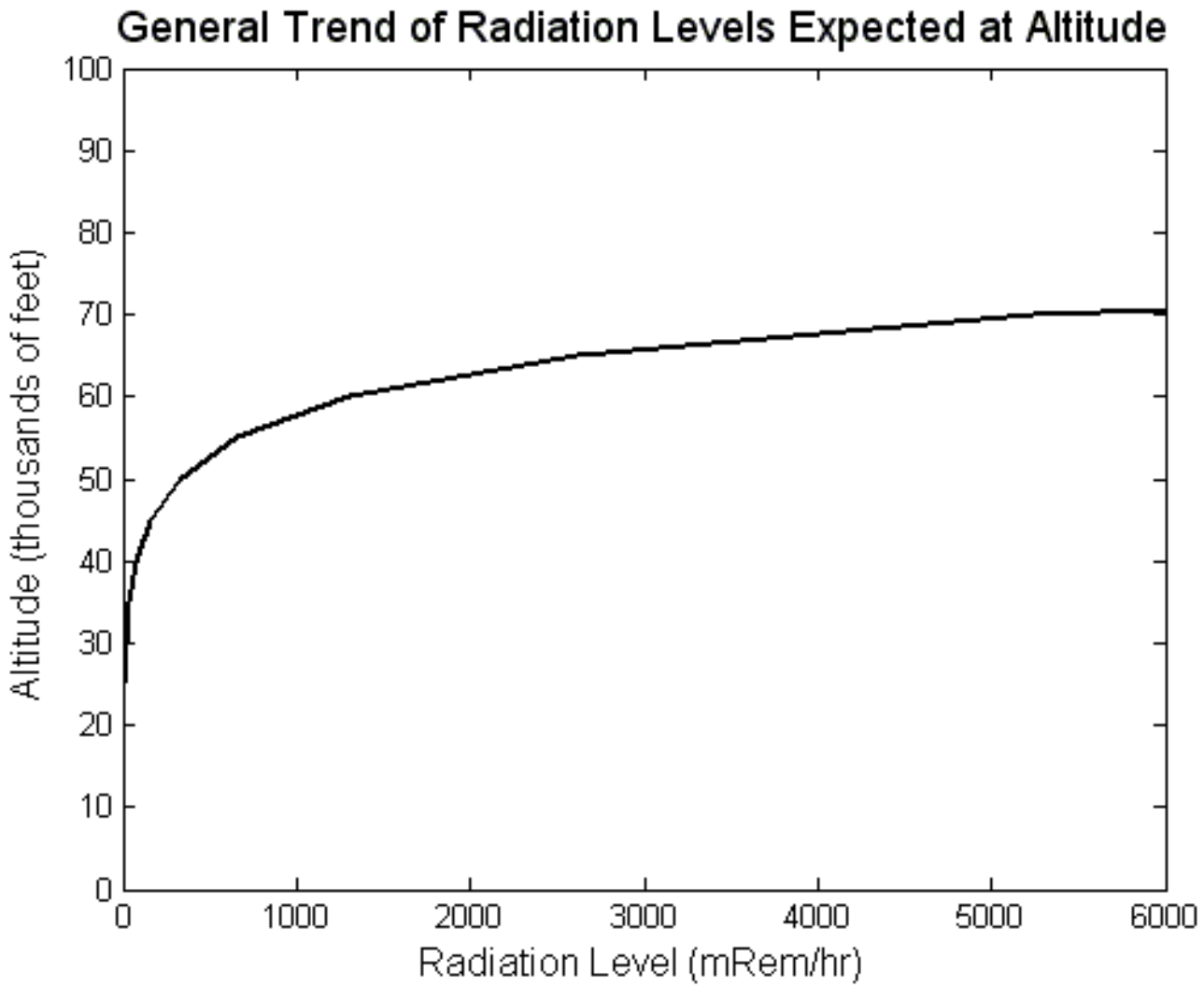
- Radiation levels roughly double every 5000 feet in altitude, so at sea level dosage will be roughly ½ the level observed in Denver, Colorado.



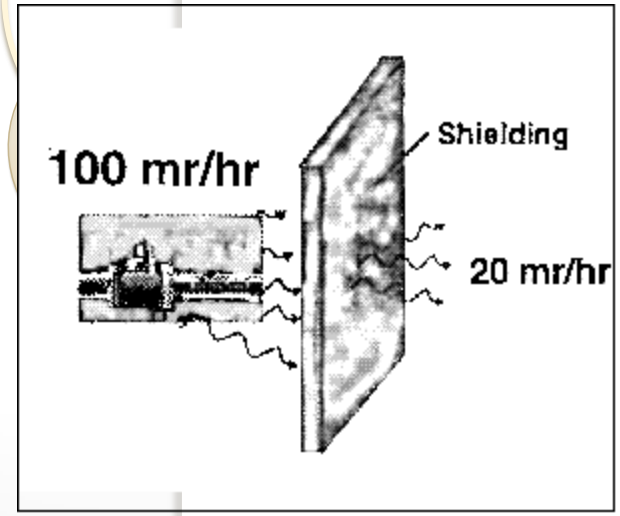
Radiation: A General Trend

- However, radiation levels do depend on the level of cosmic radiation, effective shielding, and any ground or building materials containing radioactive materials.
- In general, at sea level; you should see 12-14 counts per minute.
- This device has resolution to 2 μs. Which indicates it cannot detect particle events closer than 2 μs to each other.

Radiation: A General Trend



Radiation: Dosage and Limits



Shielding can drastically reduce the observed dose. Be sure to wear safety glasses when handling the material.

-Max dose for occupational workers (Nuclear Power) 5 Rem/yr (max exposure to retina). [2]

-Max dose recommended for the general public 100 mRem from a high energy source over a short time frame. [2]

-An average American receives 360 mRem/yr from natural background and manmade sources. [2]

[2] http://www.jlab.org/div_dept/train/rad_guide

Radiation: Comparisons

-A typical radiation dose from a chest x-ray is about 10 mRem per x-ray (Gamma exposure) [2]

-Consumer products contain radiation, such as: smoke detectors, and lantern mantles. This dose is relatively small as compared to other naturally occurring sources of radiation and averages 10 mRem in a year (Alpha exposure). [2]

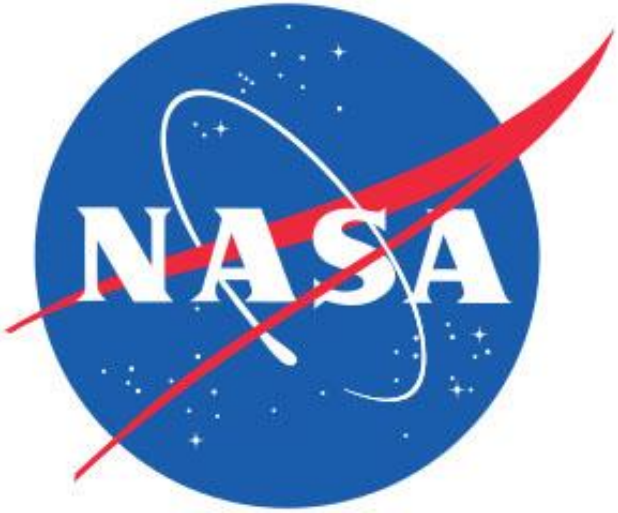
20th Century Fox ©

Radiation: Conversions

- Generally, 75 counts per minute (CPM) is equivalent to 1 mRem/hr.
- Therefore, 4500 CPM is roughly equivalent to 1 mRem
- A source from a smoke detector makes up 2.8% of the yearly average expected dose, which is .027 mRem/day or .0012 mRem/hr
- These numbers shouldn't alarm you, an average person receives 1 mRem per day.

20th Century Fox ©

Let's Start Building!

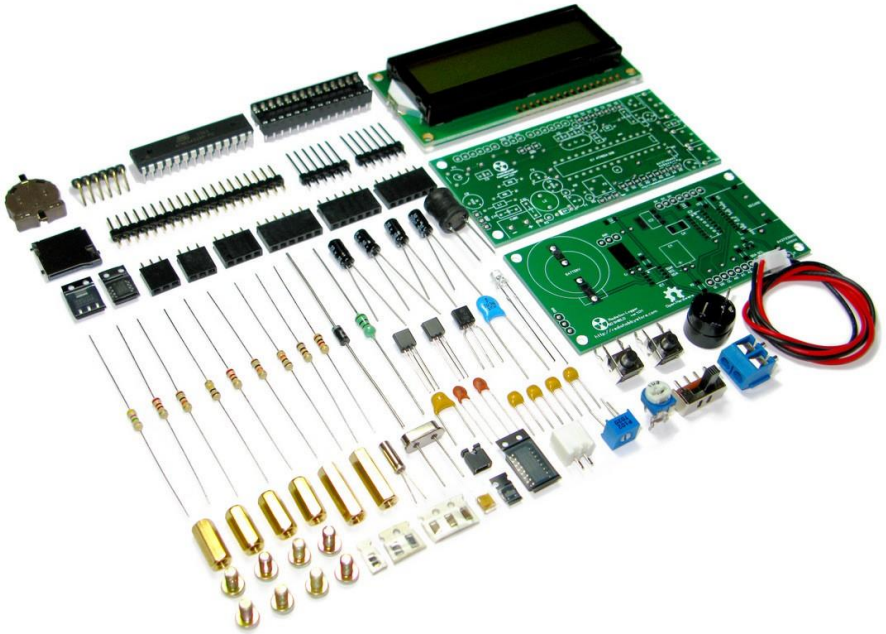


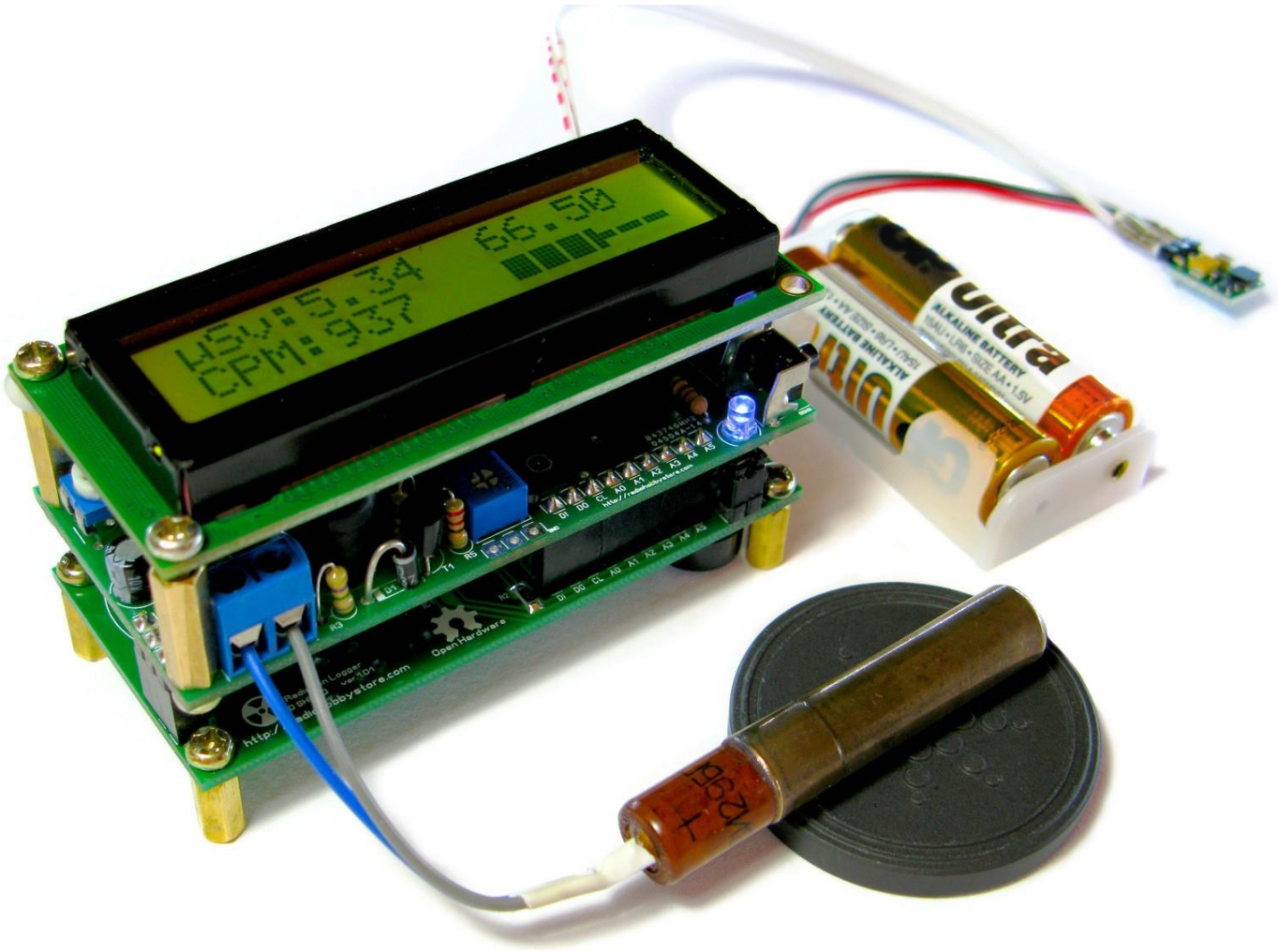
What Are We Building ?

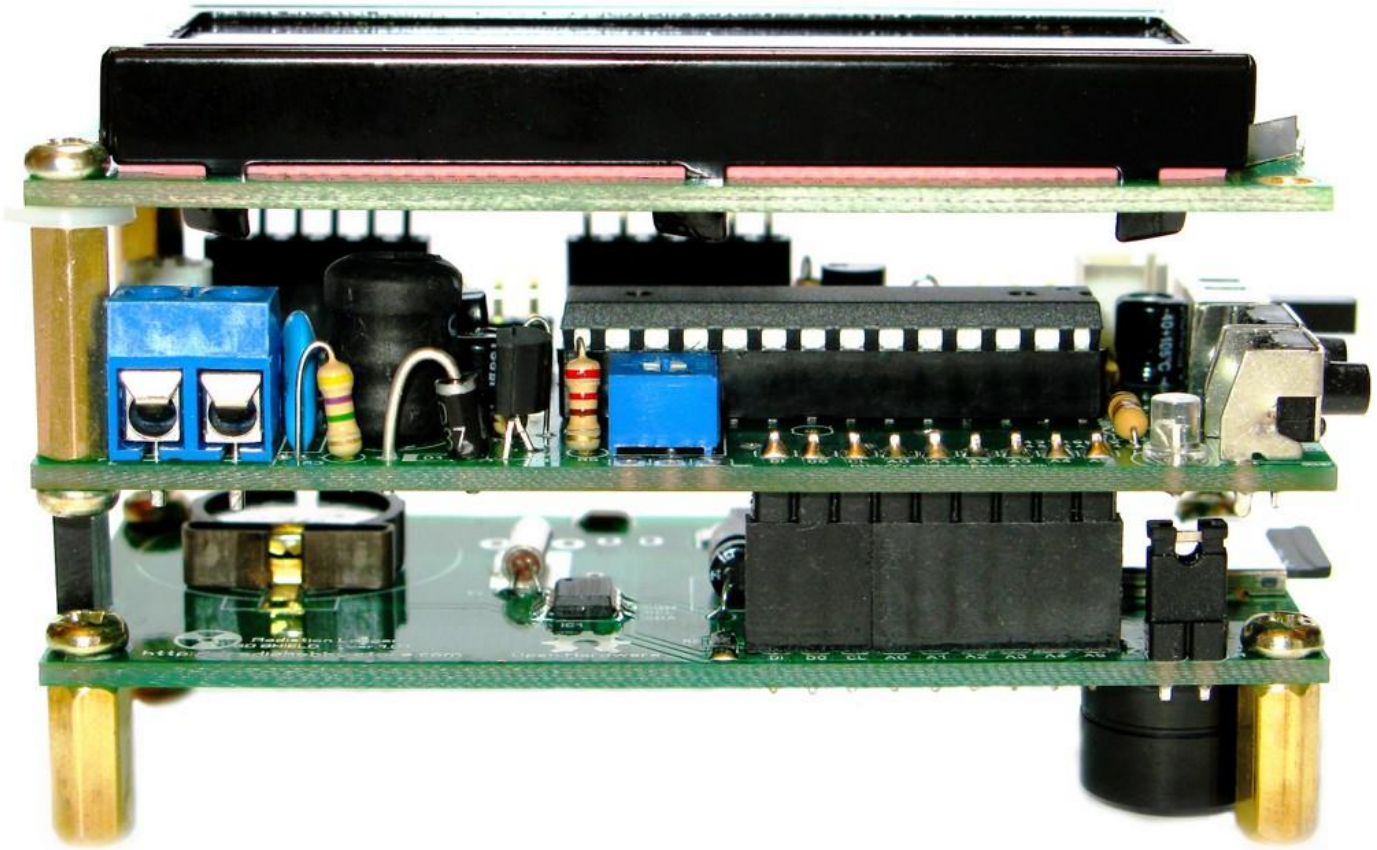
- Basic Geiger Counter

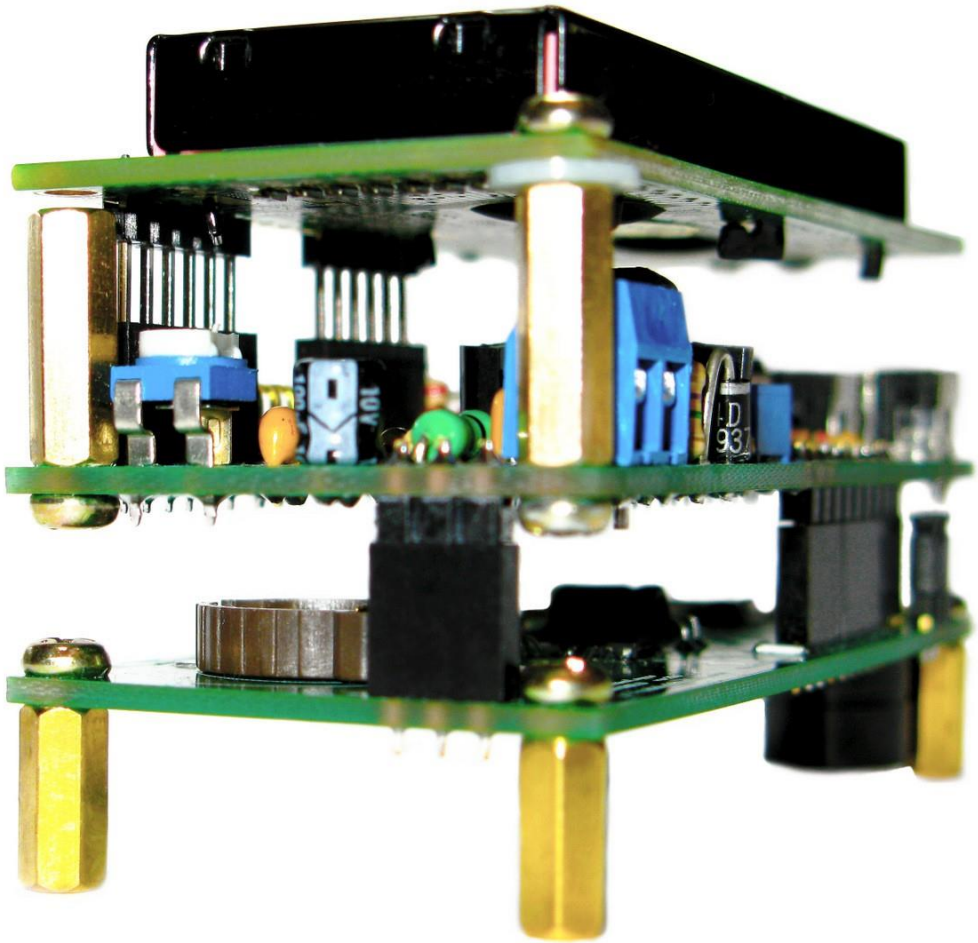
- Audio and Visual Cues for Radiation Detection

- Can detect Alpha, Beta, and Gamma Radiation.




uSv:0.34
CPM:037
Ultra
ALKALINE BATTERY




10V

Quick Overview

Arduino IDE DIY Geiger Kit ver. 1.01 with SD Logger Shield for micro SD card

This is open source code Geiger SD Logger project based on Arduino IDE. The kit includes main board with 16x2 LCD and SD Logger Shield. We supply electrical circuit and Arduino source files for this project.

SD Shield has RTC circuit (real time clock), 3.3V level shifter for SD card, Buzzer and micro SD socket. Support connection of Adafruit GPS module or UART logging through RX TX pins. Files on SD card contains CPM readings for each data point, your local date and time, nmea geographical data and total absorbed dose. 400V high voltage for GM Tube produced with PWM. Microcontroller program correct high voltage if battery capacity is too low. The kit makes clicker sound similar to a "classic" Geiger counter sound.

Technical specifications:

Geiger Tube Compatibility: GM Tubes with anode voltage 350-550V

Arduino IDE compatible, minimum hardware for maximum performance

LCD 16x2 HD44780

Two tact buttons for controlling the software

Moving Average calculating algorithm

Represent dose in uSv/h or uRn/h units

UART logging with "Radiation Logger", require USB-TTL dongle

Adafruit GPS module support

SD Shield Board with RTC

Absorbed dose, CPM, NMEA logging

Smart Backlight Control

Fast Bargraph on LCD

Clicker Geiger Sound, Buzzer installed on Shield PCB

Low Battery Indicator

Clock 24 hours format

Supply Voltage: 5V DC or Battery

Supply Current: 25mA without backlight

Dimensions: 81(L) x 37(W) x 50(H) mm

Shipping Weight: 250gr

Radiation SD Logger based on Atmega-328 and programmed with Arduino IDE. SD Shield has SMT parts that require good soldering skills! Atmega microcontroller comes with Arduino IDE bootloader, but you need to upload supplied sketches by yourself.

The main benefit of this kit is SD Logger Shield. It support micro SD Cards with capacity 2Gb-8GB. Radiation data stored with 3 files. Each time you starting the counter, it will create a new log files and the older files stay safe on card. Up to 100 files can be created before you need to clear SD memory. LOG.CSV store CPM readings for each data point. The file can be opened with our "Radiation Logger" Windows application for building graph or with any csv editor. LOG.TXT store local date and time, CPM, aborbed dose accumulated since last minute and battery voltage. If GPS module connected, LOG.TXT will also store NMEA geographical data. DOSE.TXT file keeps only total lifetime absorbed dose. User manual describes an example how you can export nmea data to google map and add CPM readings to the map.

The software and hardware where designed to produce tube high voltage with PWM technology. No additional IC's required, everything is controlled with software. By default it programmed to 400V-420V and you can make fine adjust through software calibration from 350V to 480V. If required, the kit can be adjusted for 500V-550V. For higher voltage it possible to make 600V hardware mode with voltage multiplier.

When using batteries for powering the counter, you do not have to worry about tube voltage drops because of low battery, microcontroller will correct high voltage if your battery capacity is half or low. Battery indicator on LCD will work only with Ni-MH type.

The kit compatible with many popular Geiger tubes, such as SBM-20, SBM-19, SI-29BG, SI-180G, SBT-9, SBT-11, J305 and more 400V tubes. When it tuned to 500V you can use LND-712, LND-7317 or similar.

Current radiation dose in uSv/h or uRn/h units represented on LCD with CPM (counts per minute) readings. You can switch between LCD units with pressing "down" button. If you press "up" button, it will shows clock for several seconds, like a digital watches. RTC needs 3V backup battery CR1220. This battery is included. PCB allows you to use CR2032 backup battery for RTC with other low cost holder type.

Adafruit GPS module can be connected to RX TX pins and selected through sketch settings during firmware uploading. If no GPS presented, you can use RX TX pins for UART logging. CPM value logged through UART to our "Radiation Logger" Windows program. When connected to computer, the kit can be used as nuclear radiation monitoring station for local logs, radmon or xively. It possible to separate SD Shield from the Main Board if kit used only for UART logging.

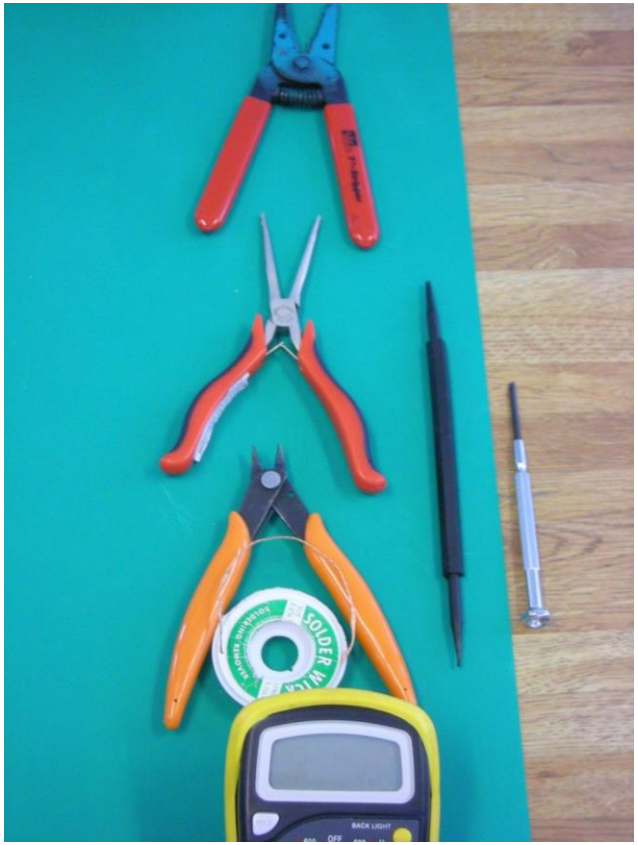
Fast bargraph on LCD for search mode represent CPS (count per second) measurement. The scale controlled through arduino sketch.

The counter has smart LCD backlight controlling for saving battery. Backlight will light on when CPM value reach presetted alert threshold or if you press any button. Alert BL pin is combined with LCD backlight and can be connected to additional alert led or drive relay module.

The kit produce clicker sound beeps similar to "classic" Geiger Counter sound. You can mute buzzer with jumper removed. If radiation level is high, the kit inform you with additional sound indication.

Prep Step 1: Tool Layout

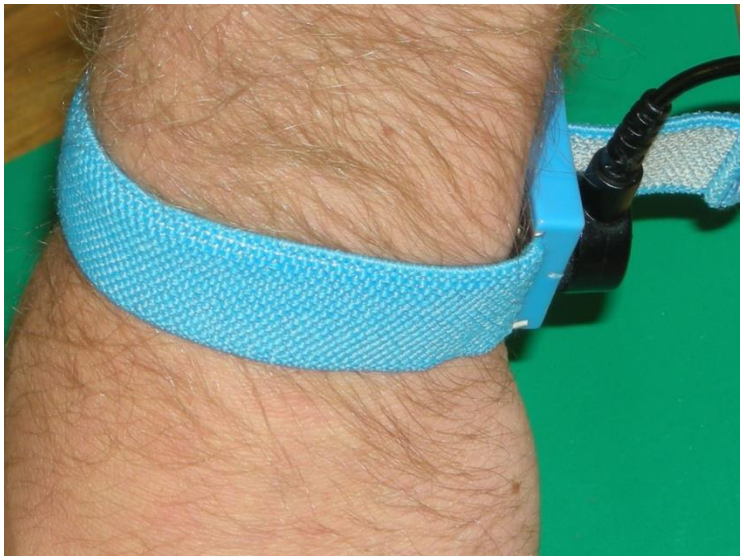
- Prepare tools for the construction process.
- Put on your safety glasses.



Prep Step 2: Grounding

- Put on a static strap to remain *grounded*. Also make sure the strap is tight across your wrist.

- This will protect any parts from electro-static discharge (ESD) and its harmful effects.



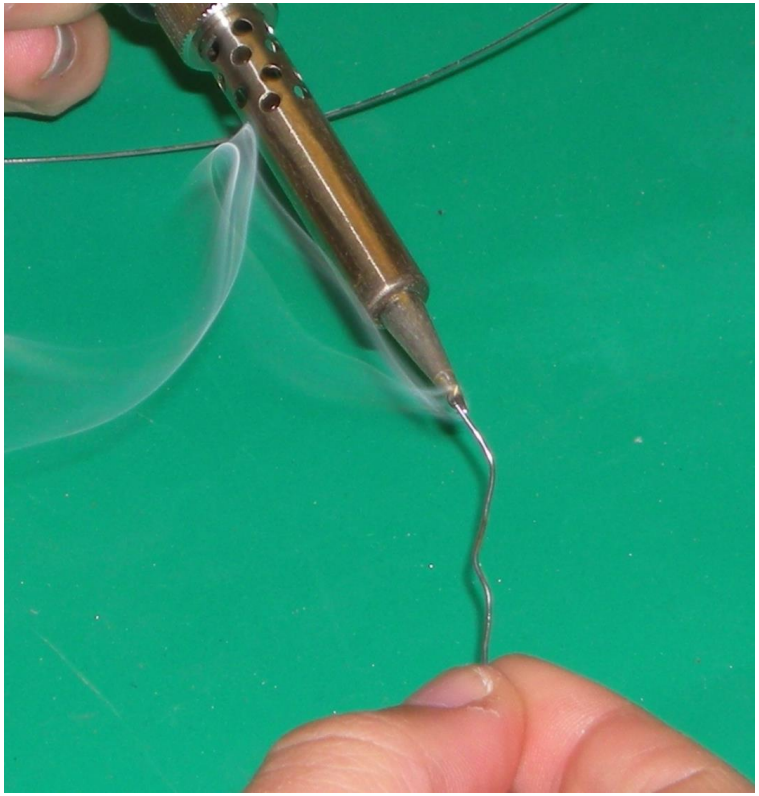
Prep Step 3: Soldering Station

- Turn on the soldering iron
- Set the temperature control on the soldering iron to a temperature less than 700 °F and greater than 450 °F.
- As a general rule use a temperature in the range between 550 and 650 degrees Fahrenheit.

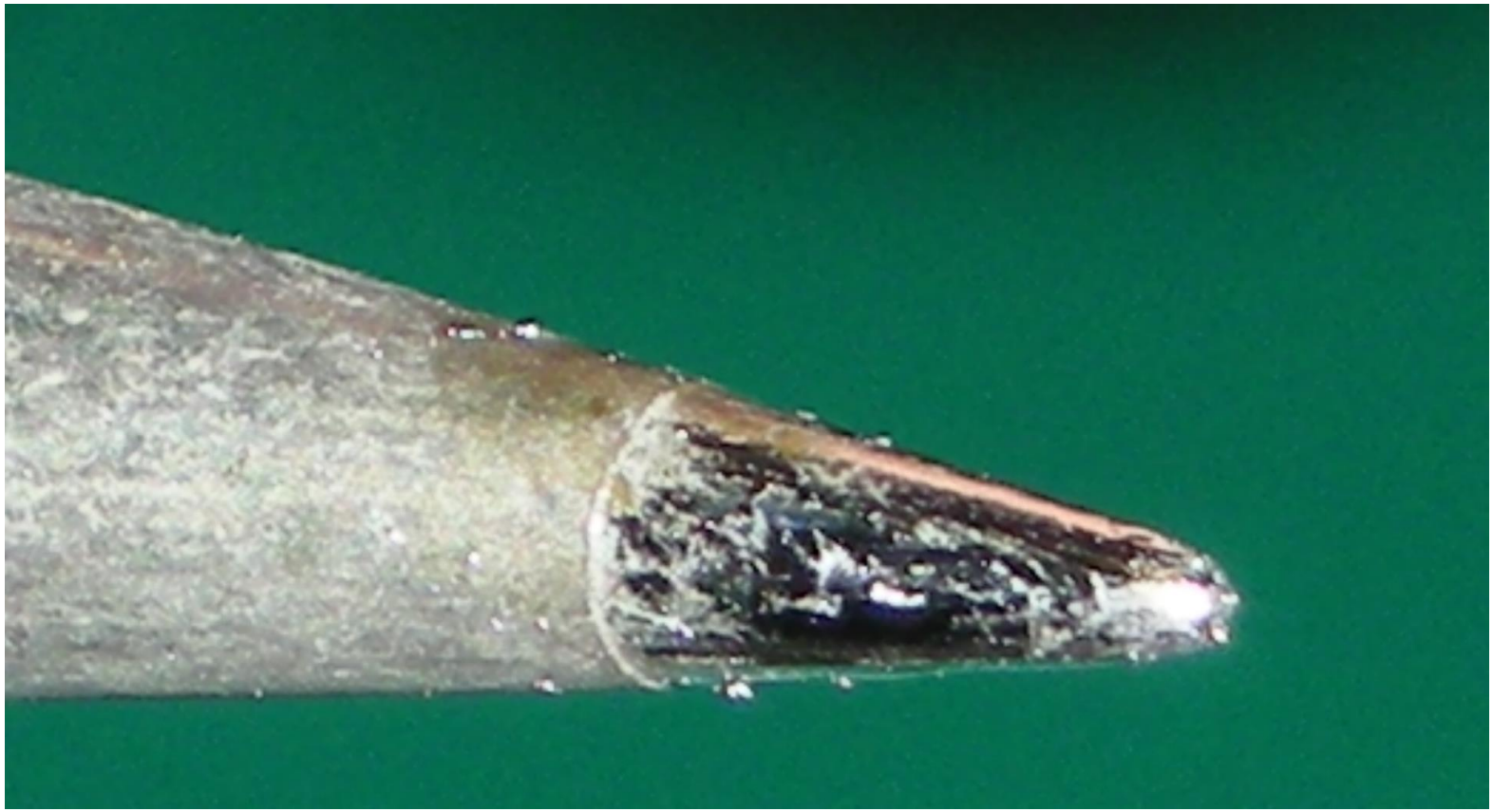
Prep Step 3: Soldering Station

Prep Step 4: Tinning the iron

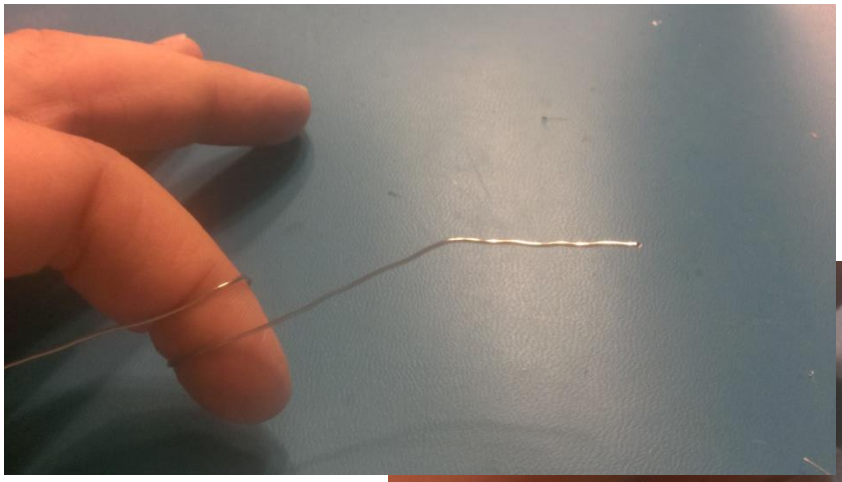
- Tin the tip of the soldering iron by melting an inch or so of solder on the tip.
- The iron will now look shiny on the tip.
- Then wipe any excess solder on the golden sponge.
- Now place the iron back into the holder. Tinning your soldering iron in this manner will aid in future soldering.

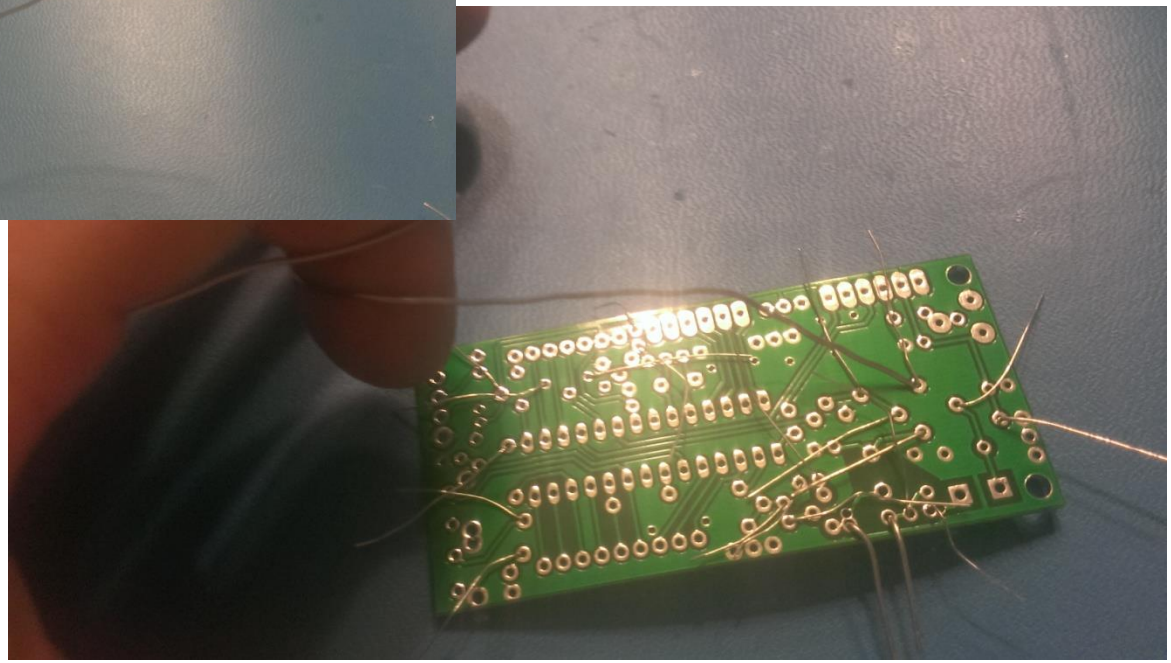


Prep Step 4: Tinning the iron (close-up)



The best way to control the solder is to wrap it around your finder and place the end on both the solder iron and metal plate.



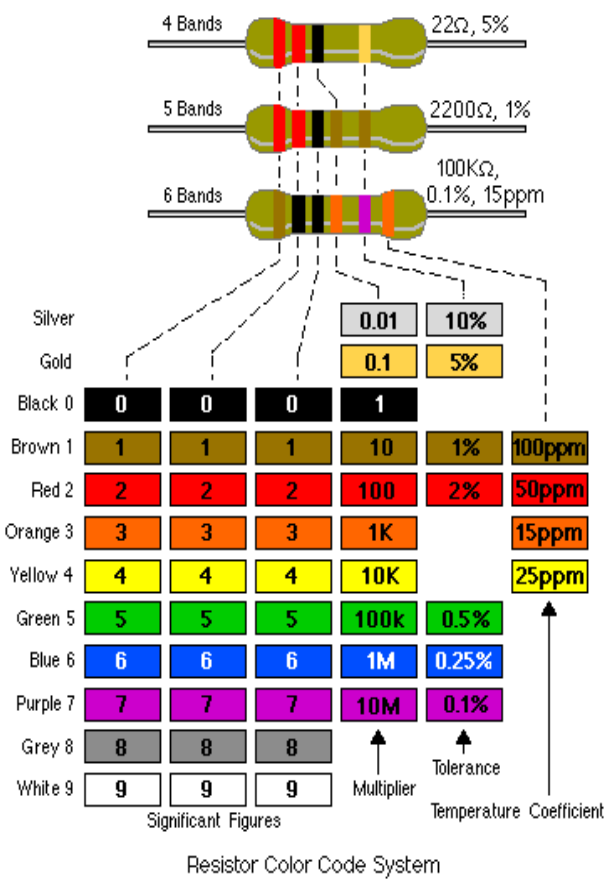


Verify Kit Contents

- Open your kits and verify the contents with the provided list and visual layout.
- Find the Geiger Mueller (GM) Tube and set it aside in a safe place.
- You won't need the GM Tube until the last few steps.

GM TUBE

Reading a Resistor:



Resistor Color Code System

The resistors in this workshop have already been organized by value.

In the event that your resistors get mixed, please refer to the chart at the left to classify your resistors, or use your multimeter

If you are unsure, don't hesitate to raise your hand and ask for assistance.

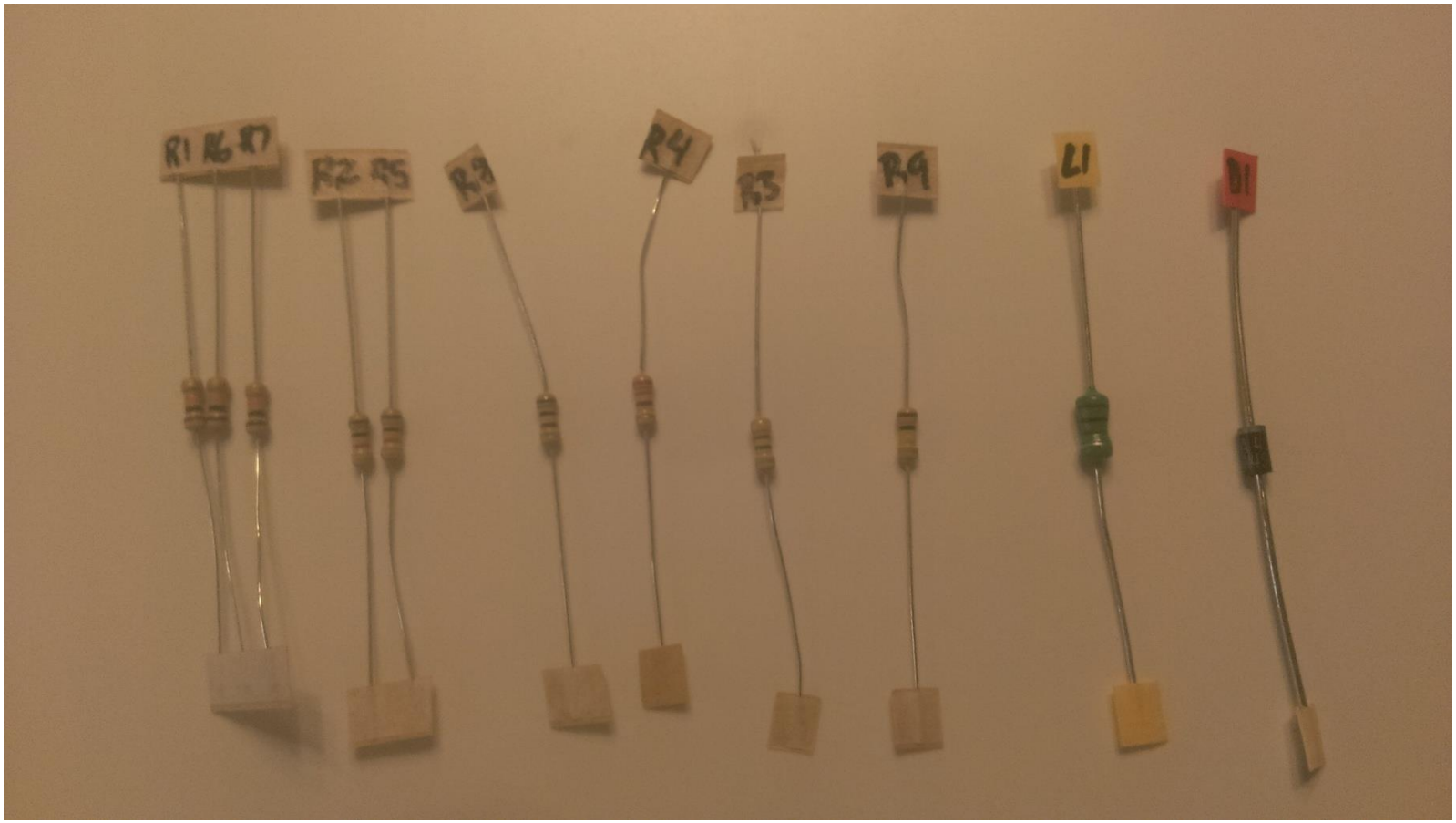
Put on Eye Protection Now

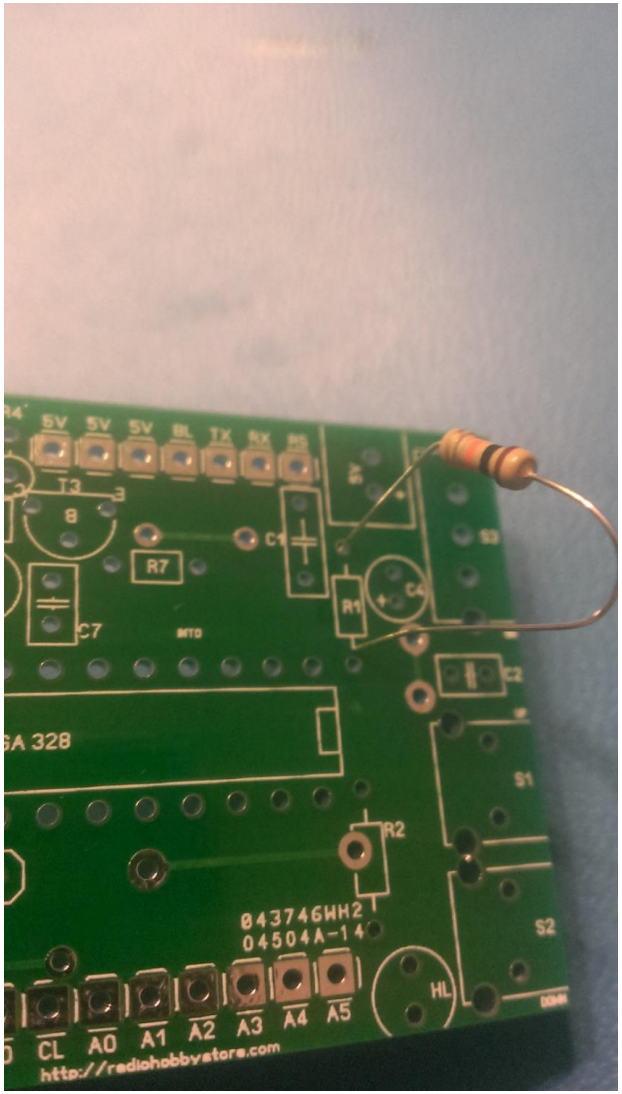
Board 1

Phase I

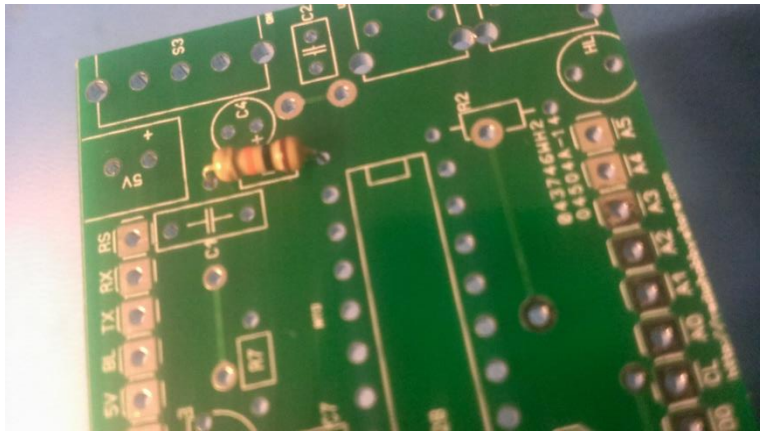
Image	Name	Quantity	Value	Description
	R8	1	100 ohm	¼ W resistor
	R4	1	220 ohm	¼ W resistor
	R2,R5	2	1K ohm	¼ W resistor
	R1, R6, R7	3	10K ohm	¼ W resistor
	R9	1	100K ohm	¼ W resistor
	R3	1	4.7M ohm	¼ W resistor

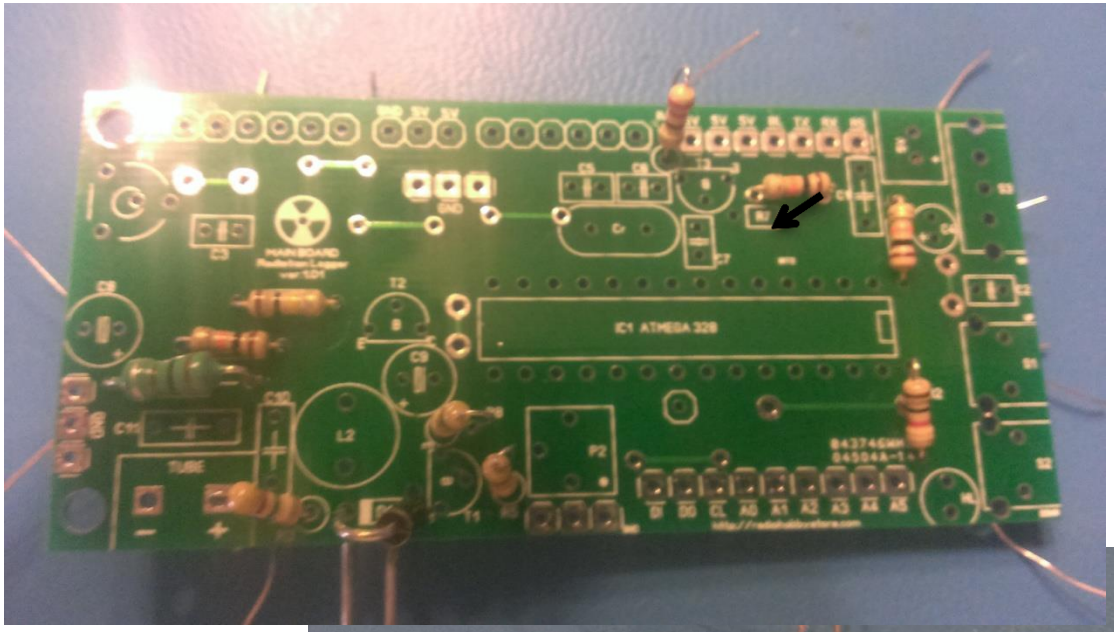
Label all resisters to match the parts list





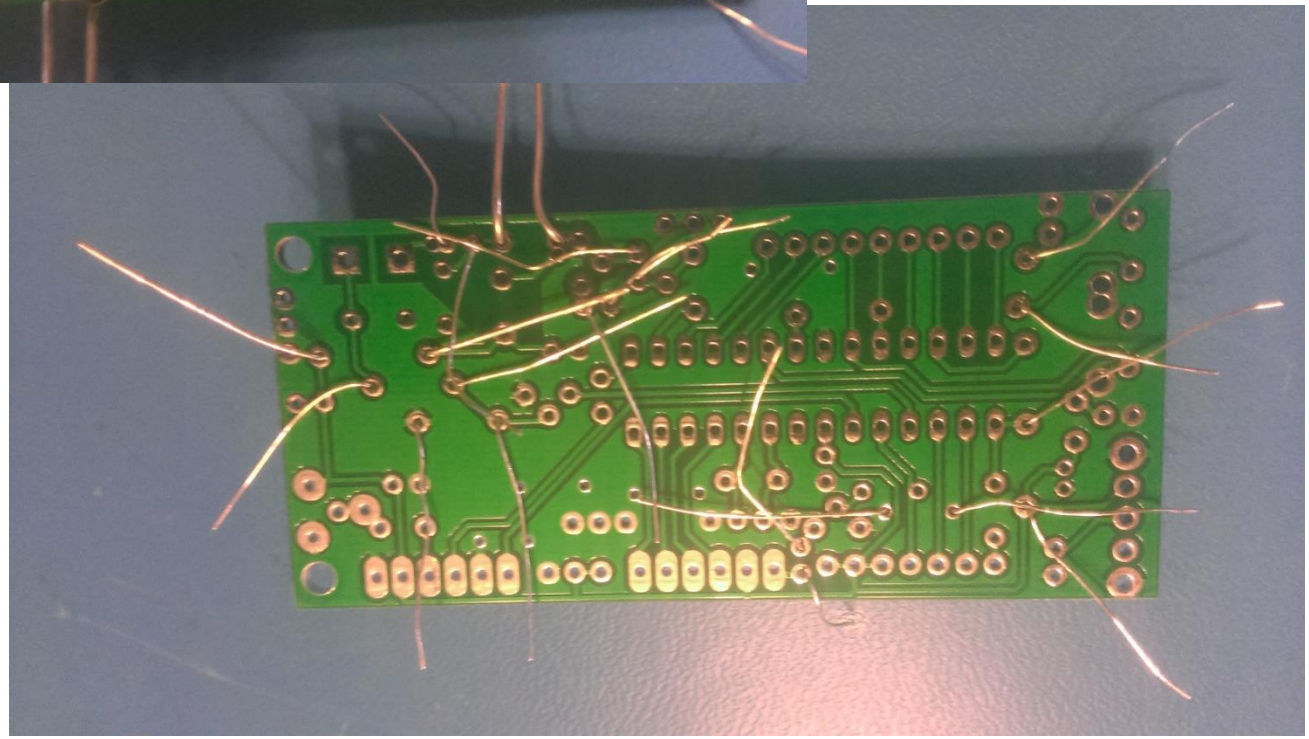
When inserting the resisters make the proper bends necessary using the bottom leads to pull all the way through.

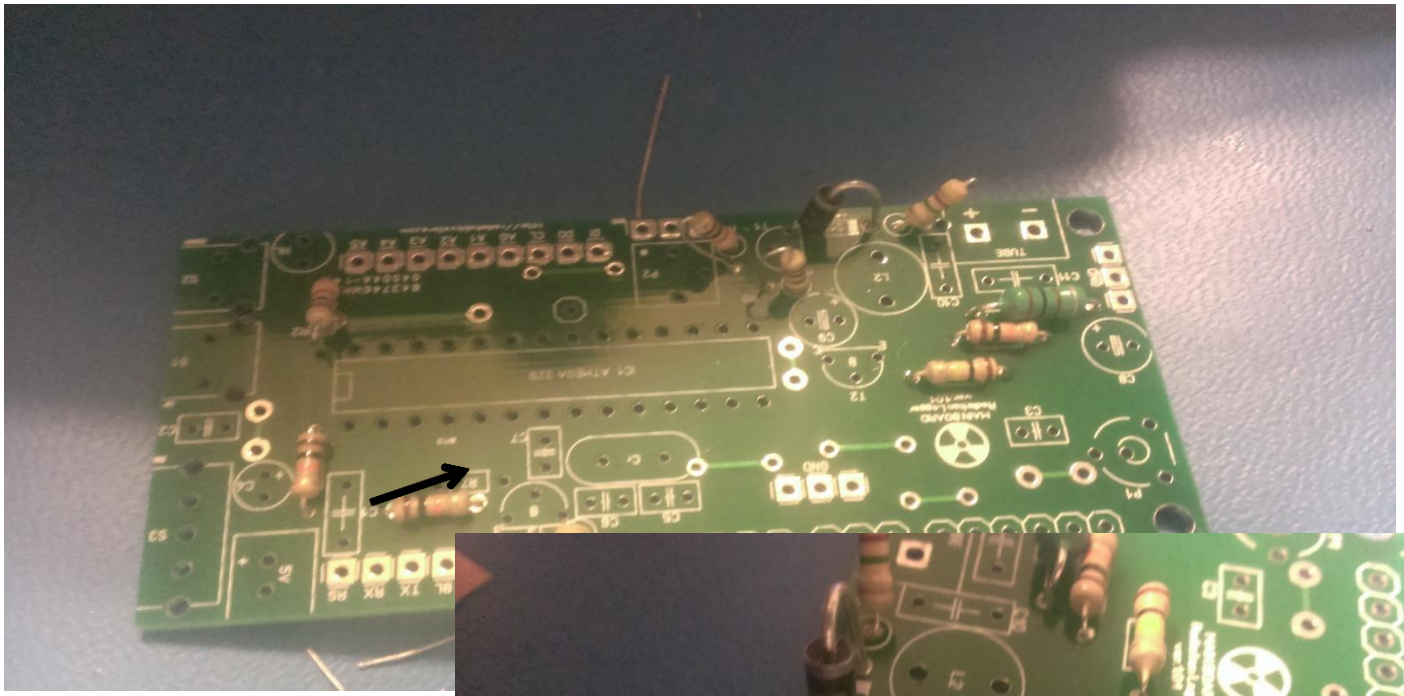


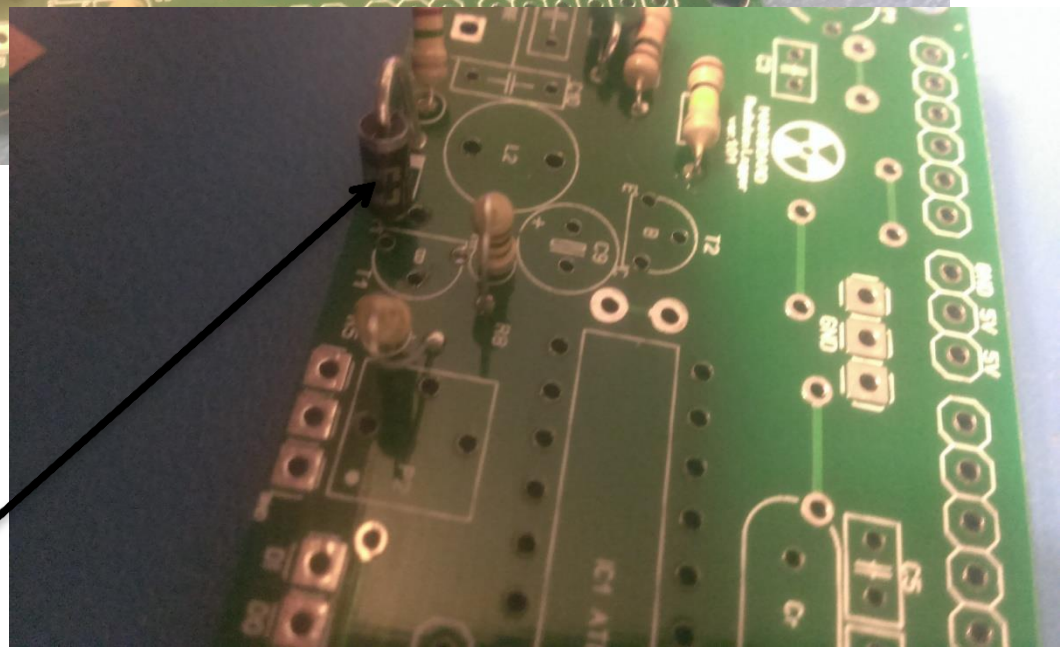


Insert all resisters and diode 1 and bending the leads to keep them in place.

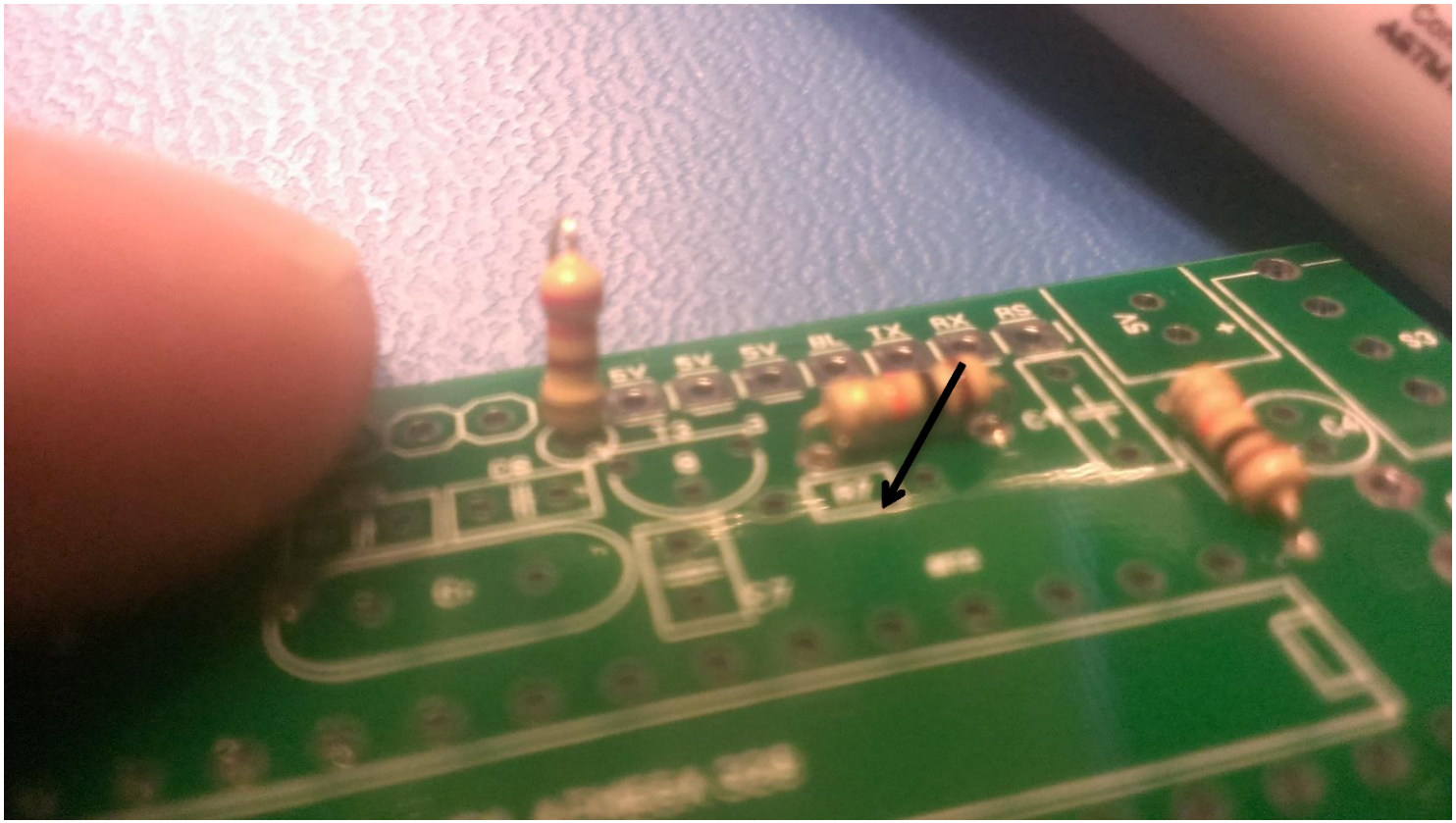
One resistor is out of place, notice the arrow and where the correct placement should be.



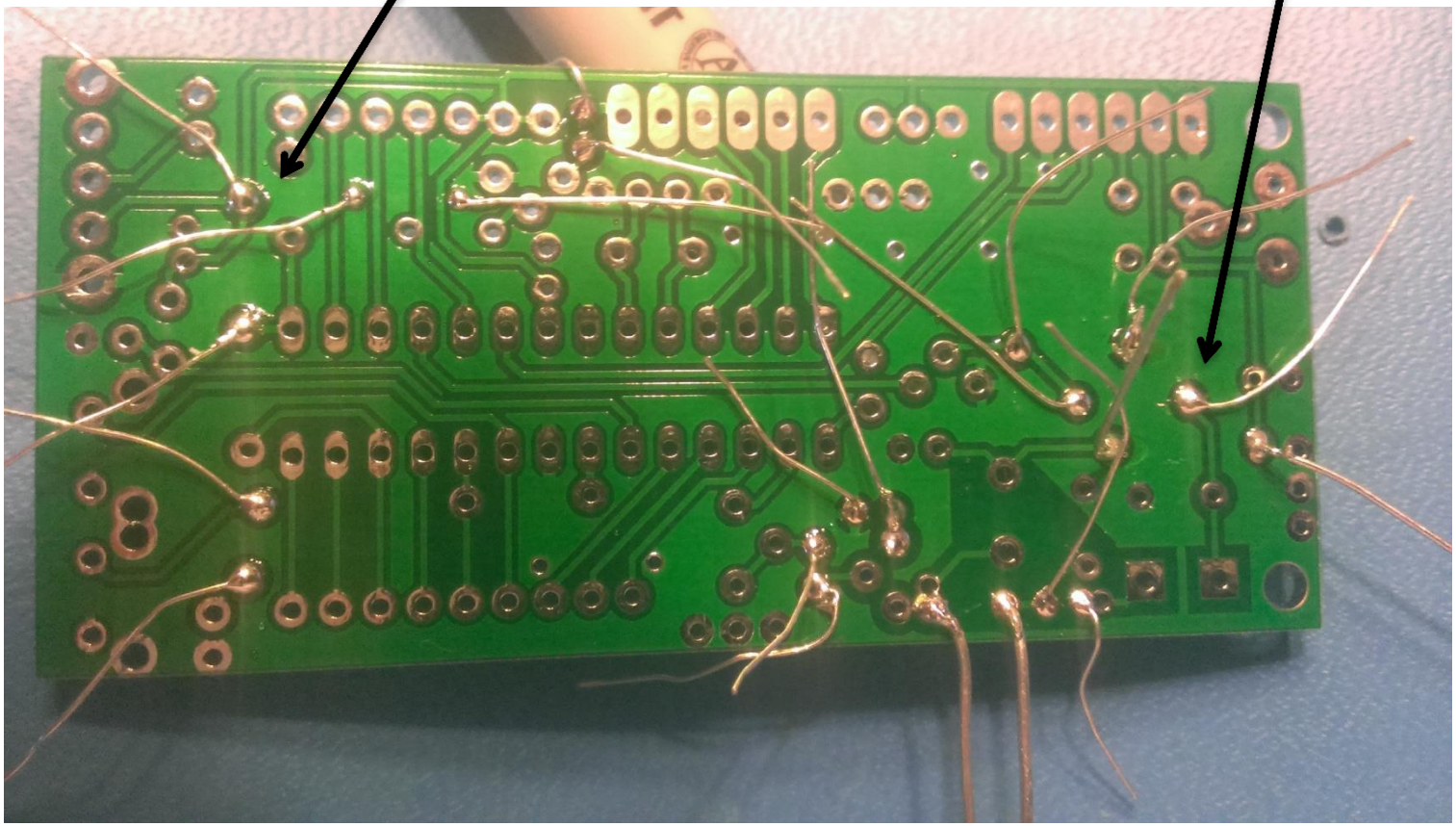




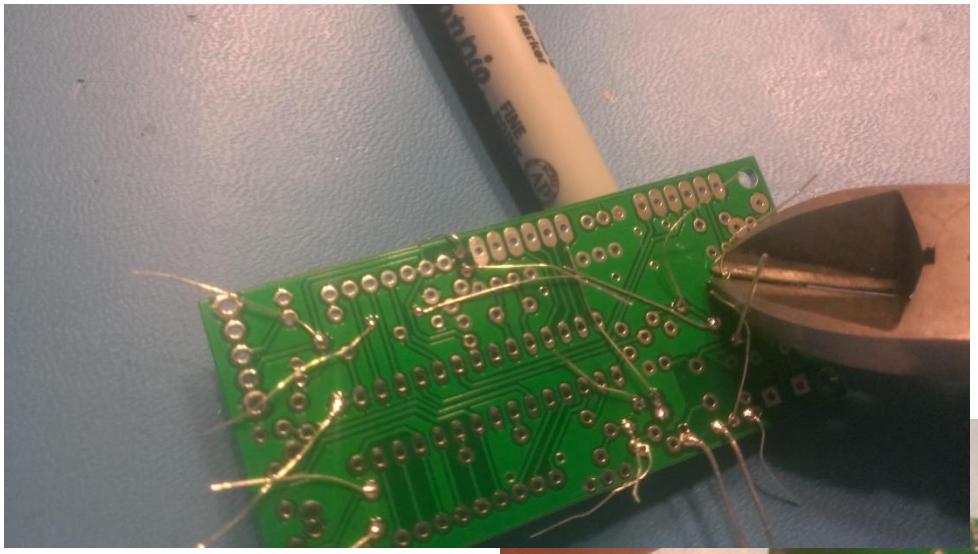
Pay close attention to the picture, if there is a circle next to the number it must stand up. D1 has polarity.

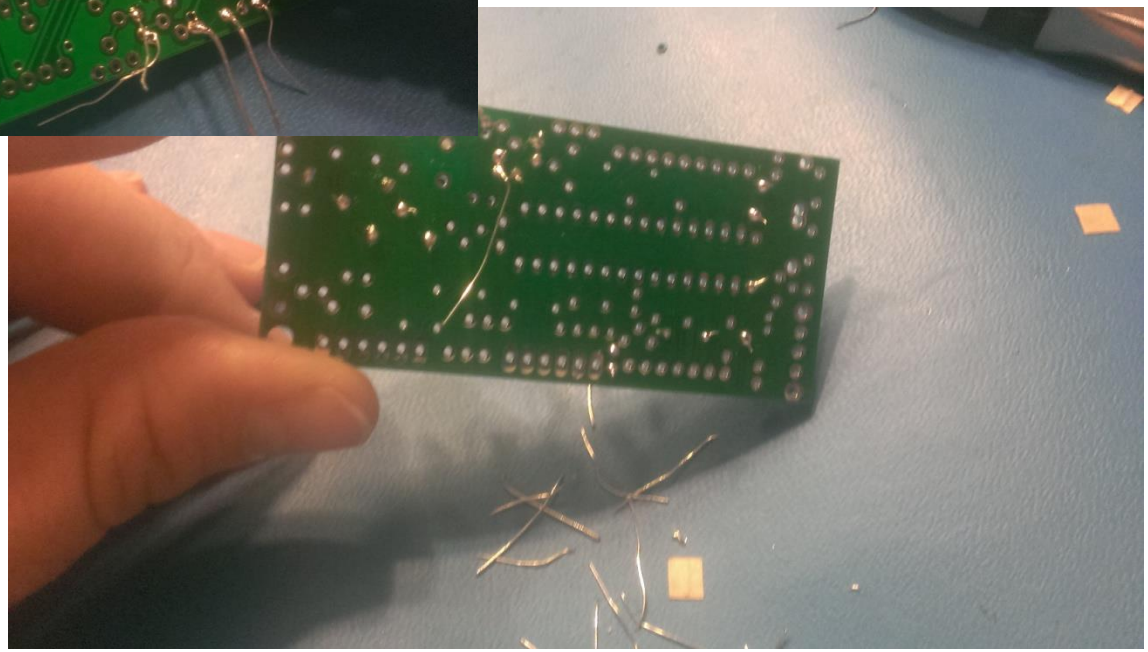

5V
5V
5V
RX
TX
RS

Solder all the leads, making sure you do not bridge to the next lead and you create that cone shape (not a ball).



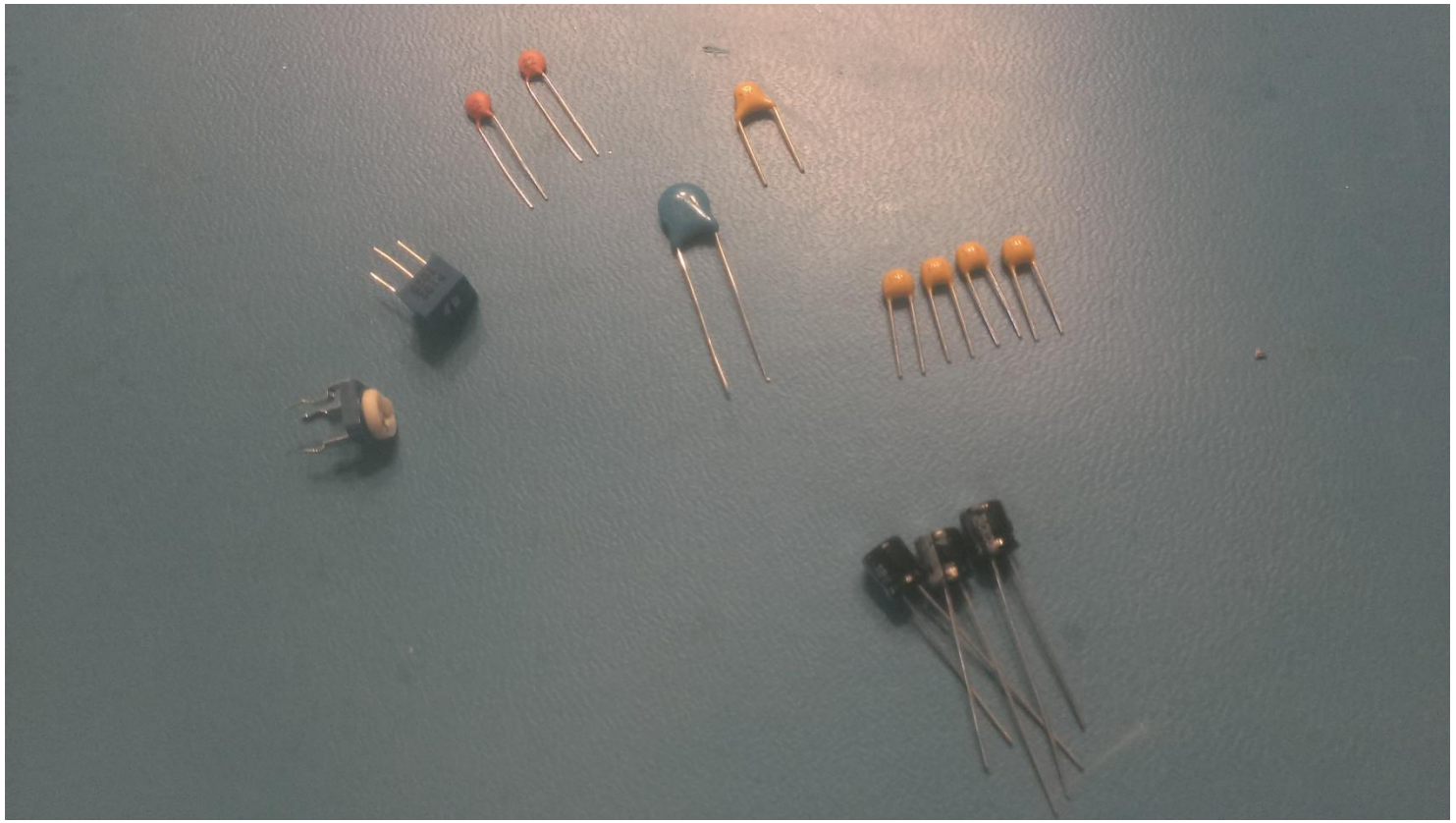
Then clip all the leads as close as possible.



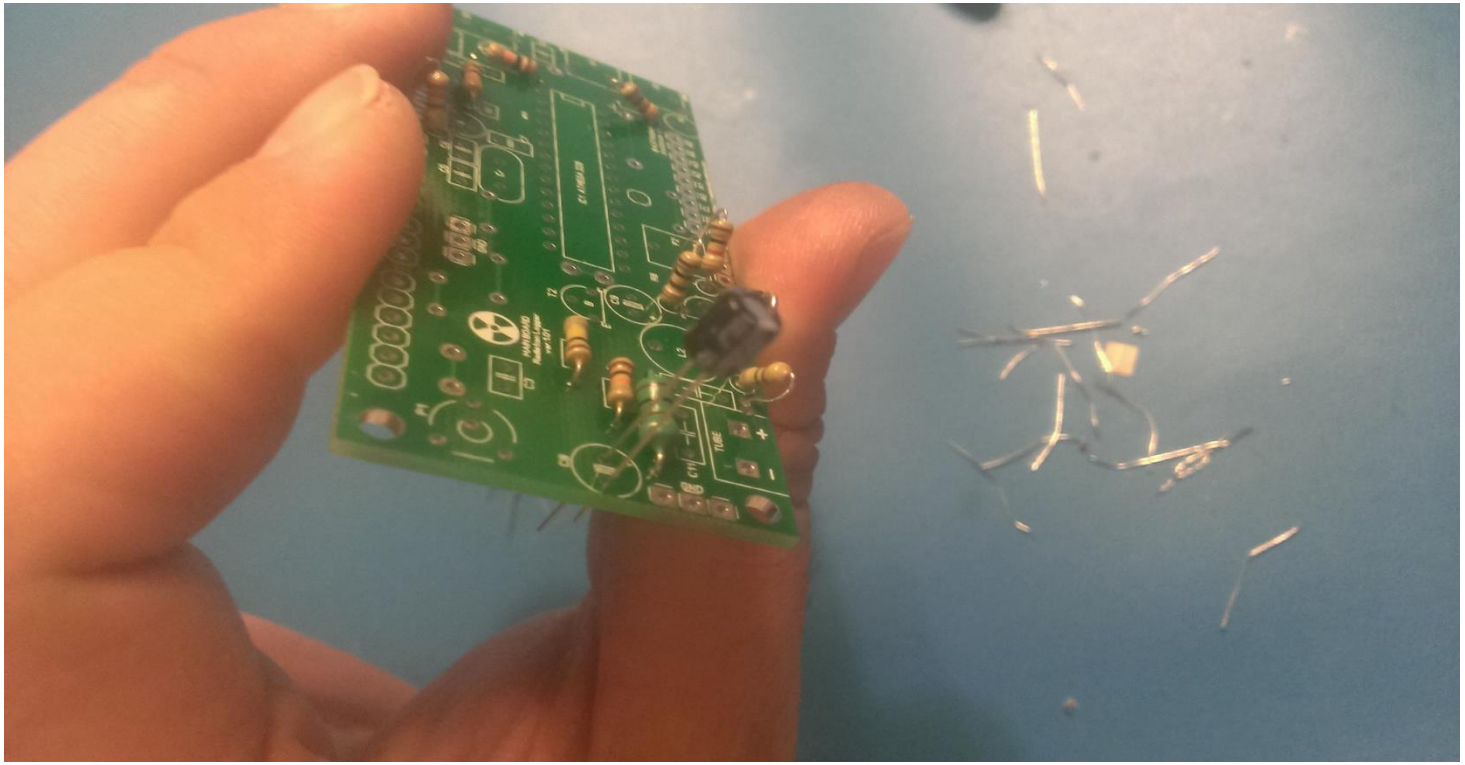


Phase 2

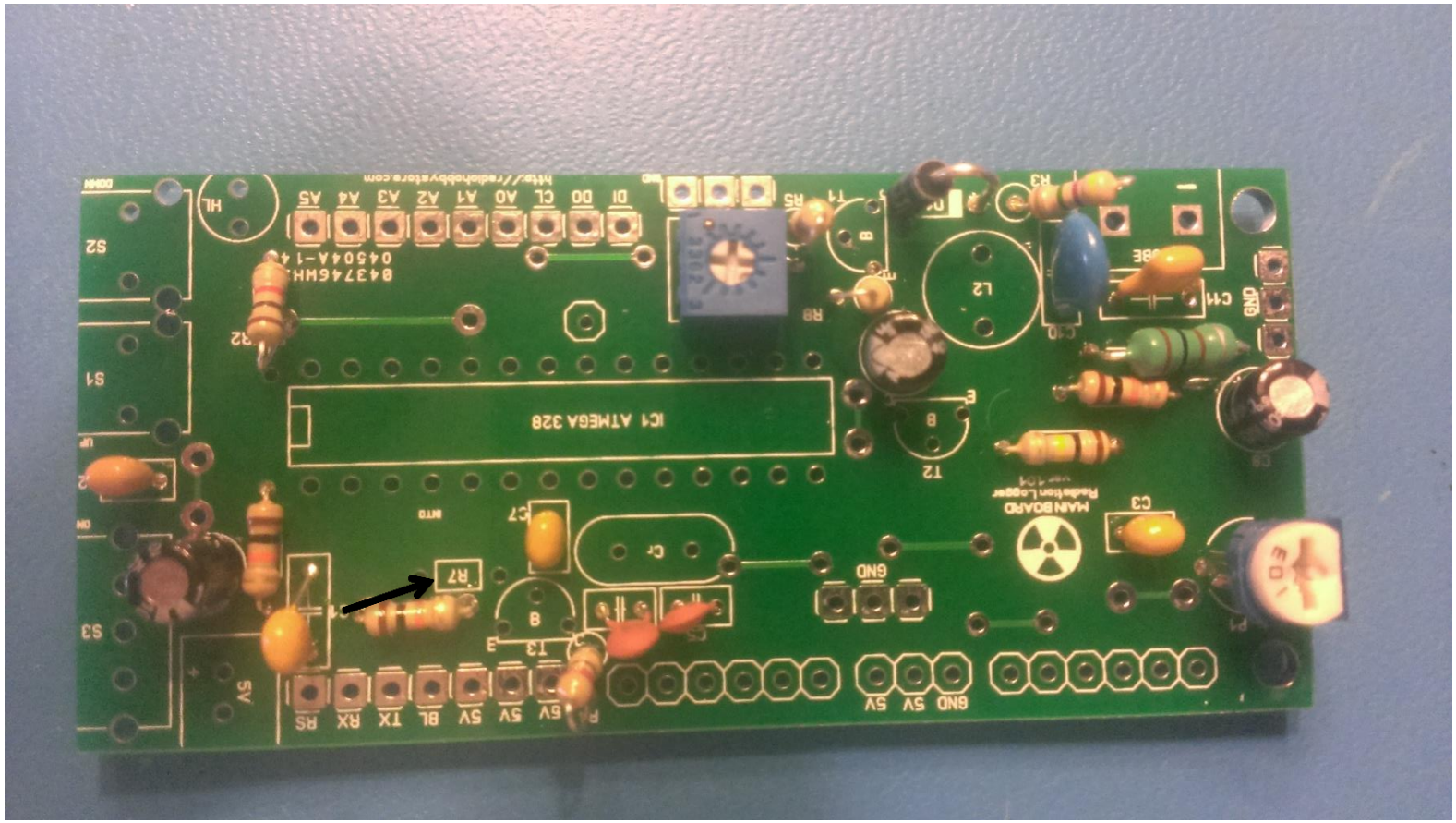
	P1	1	10K ohm	LCD contrast trimmer
	P2	1	1K ohm	HV Trimmer
	C1, C2, C3, C7	4	100nF	Ceramic Capacitor (104)
	C11	1	330pF	Ceramic Capacitor (331)
	C5, C6	2	22pF	Ceramic Capacitor (220)
	C10	1	10nF	HV Capacitor
	C4, C8, C9	3	100uF	Electrolytic Capacitor



The capacitor has polarity, the long lead is positive and negative is denoted by the (–) on the side.



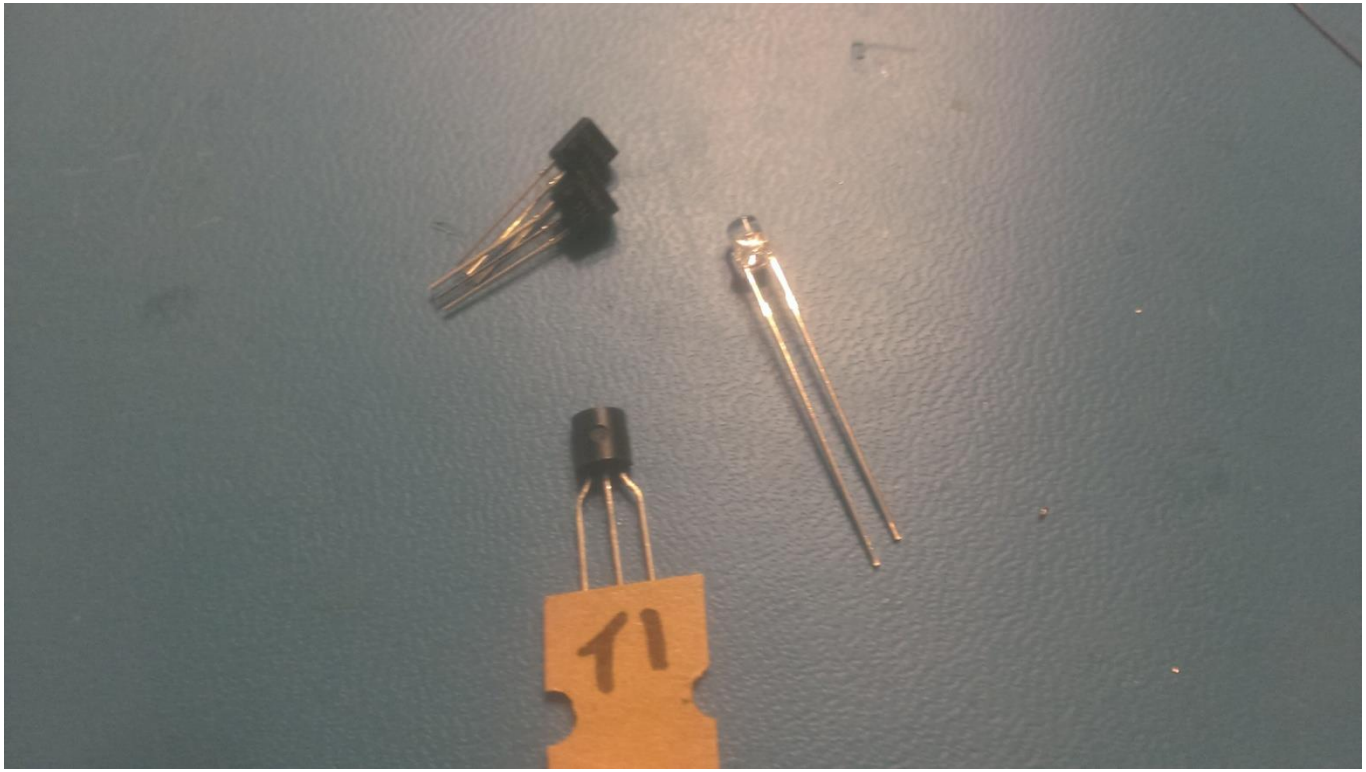
Placement is important, make sure all components are in the correct place.



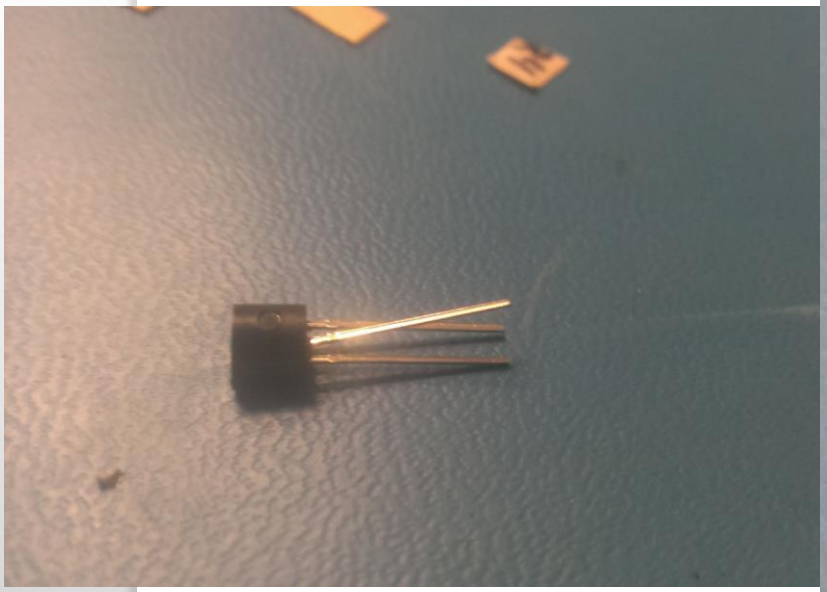
Phase 3

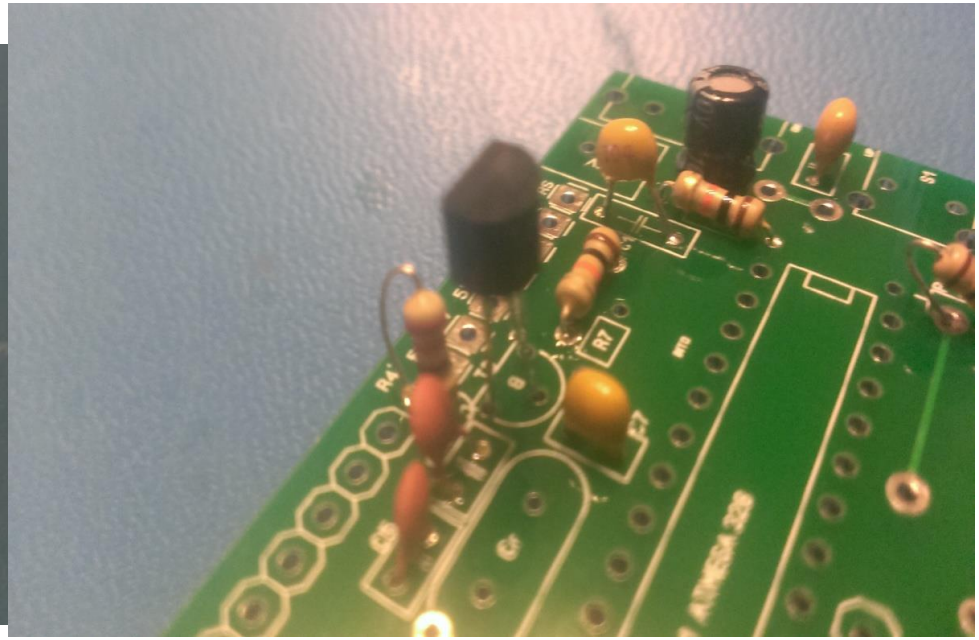
	D1	1	1N4937	Fast Rectifier Diode
	LED1	1	LED	3mm red led
	T1	1	MPSA44 KSP44	HV NPN Transistor
	T2 ,T3	2	2N3904	NPN Transistor

	L1	1	100uH	Axial Inductor
	L2	1	10mH	Radial Inductor
	Cr	1	16MHz	Crystal HS-49S
	IC1	1	Atmega 328A	Microcontroller with Bootloader

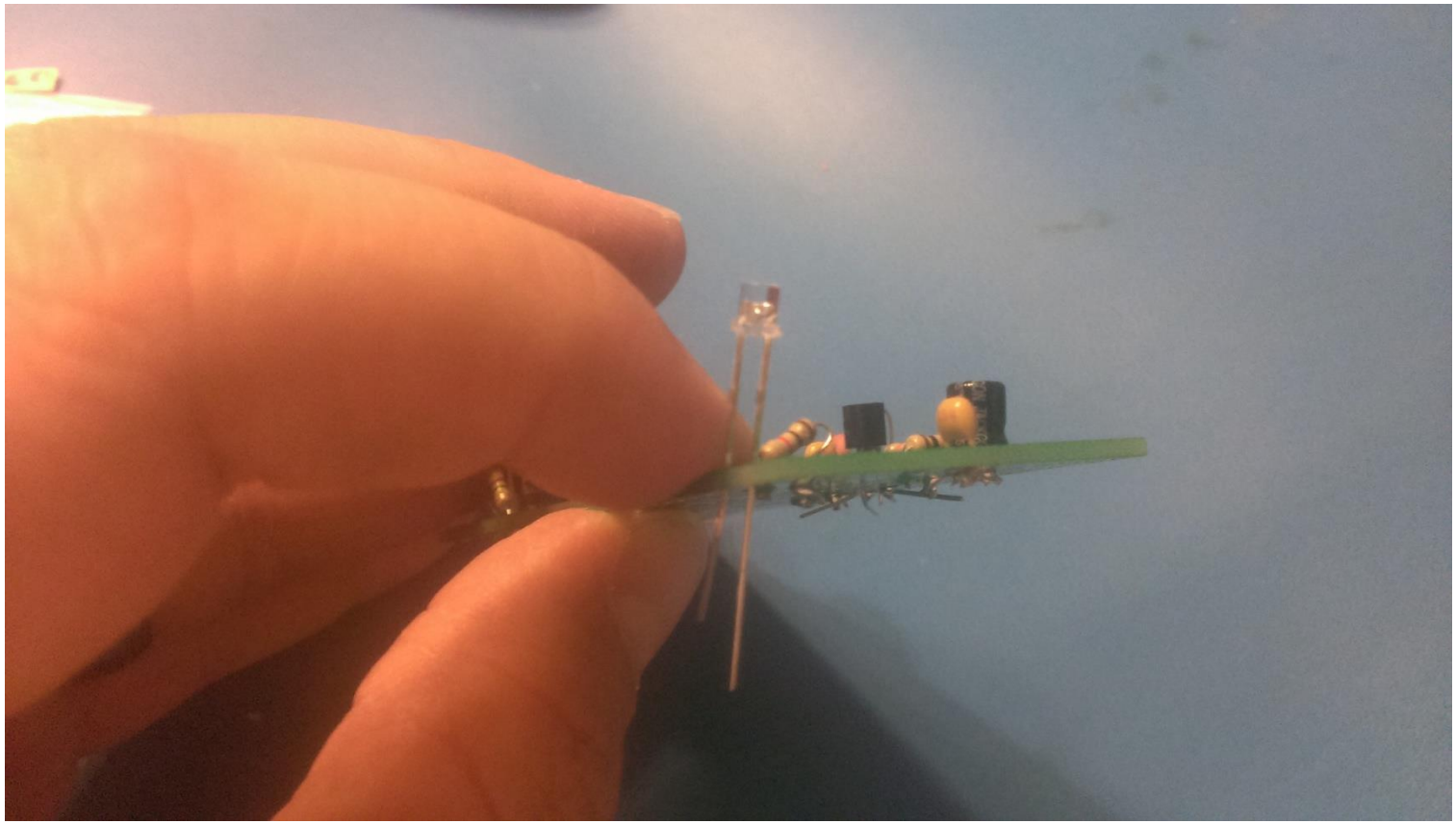

11

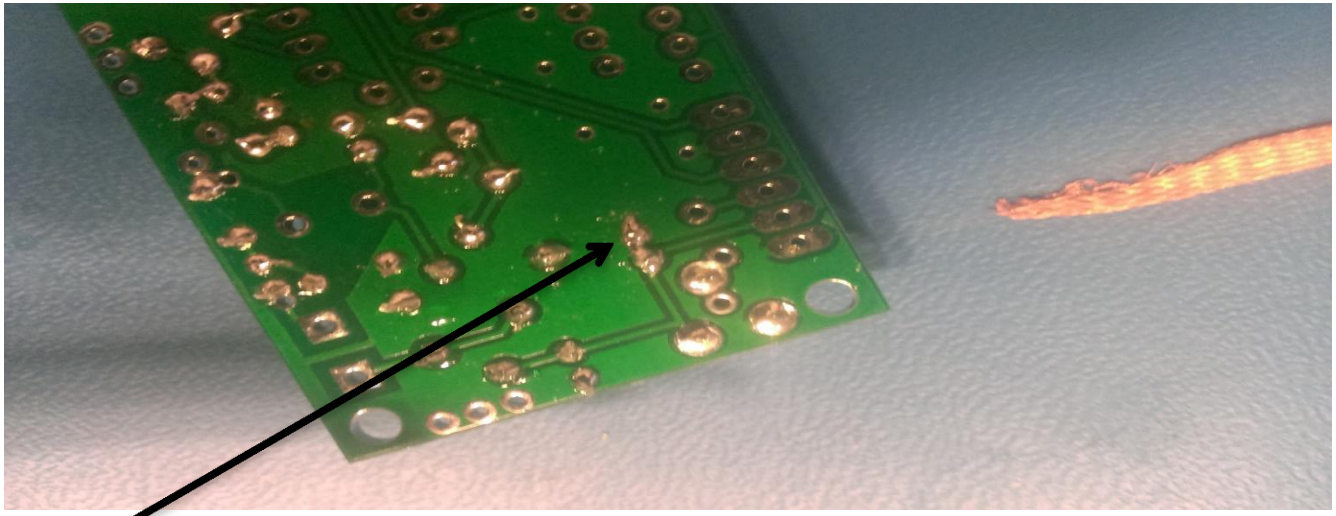
On the transistor, the middle lead is always the front and insert into the board by placing one lead in at a time. Pay close attention to the diagram and where the flat spot is.



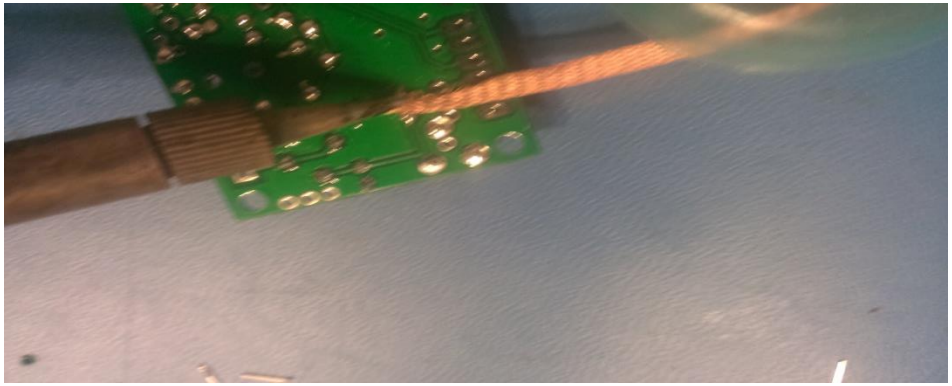


The L.E.D. has polarity. You need to always go by the diagram and where the flat spot is based on the outline on the board.

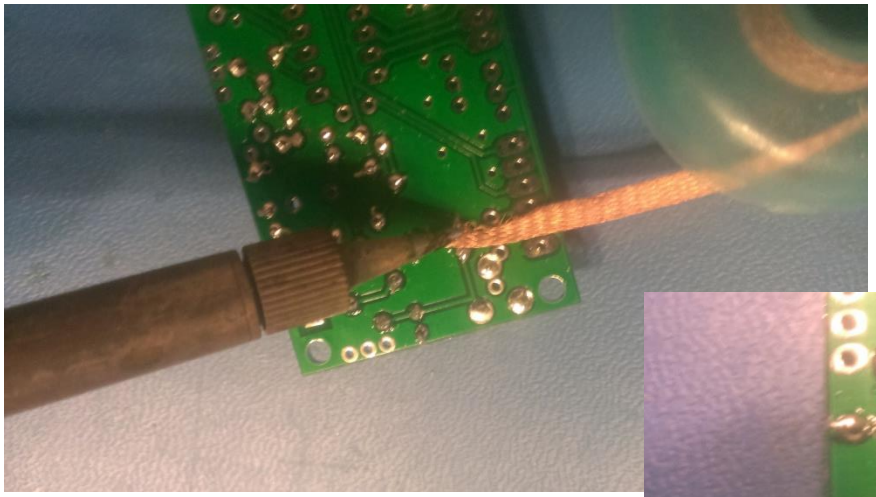


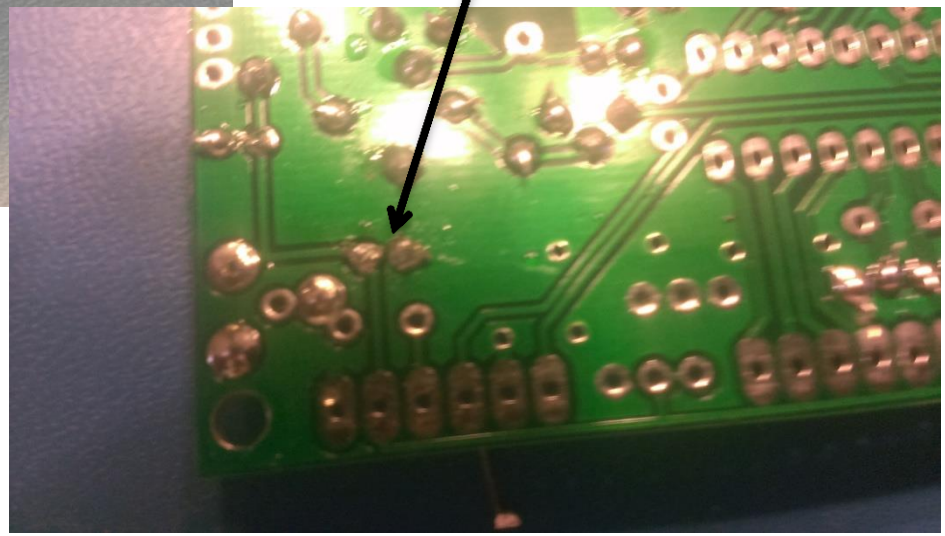


If a bridge in the solder occurs, use the solder delete or the solder sucker to remove the unwanted solder.

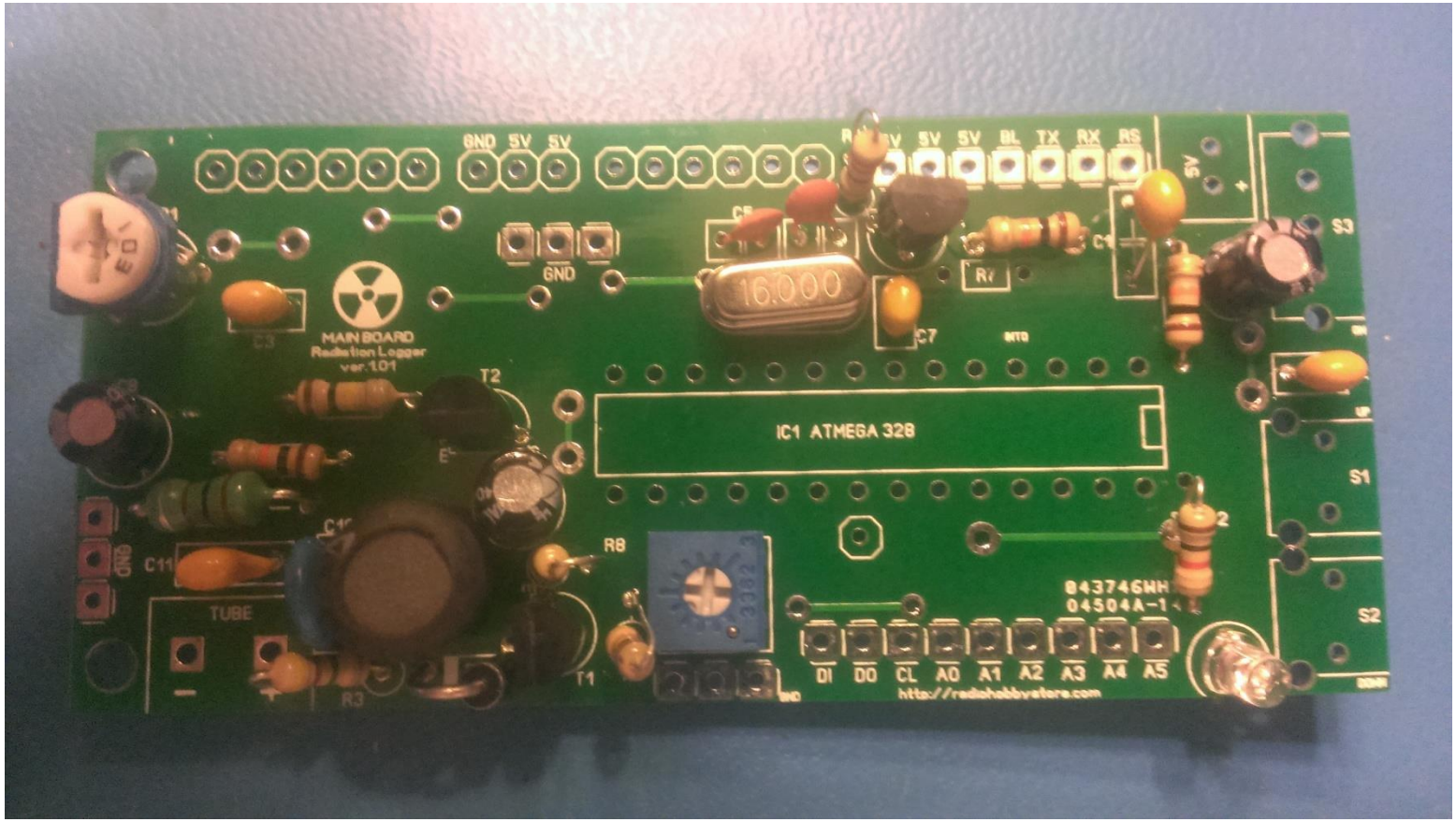


Place the solder delete on the board, and hold the solder iron on top. Hold until all the unwanted solder is gone.



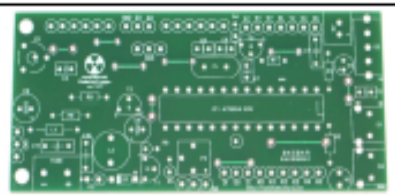


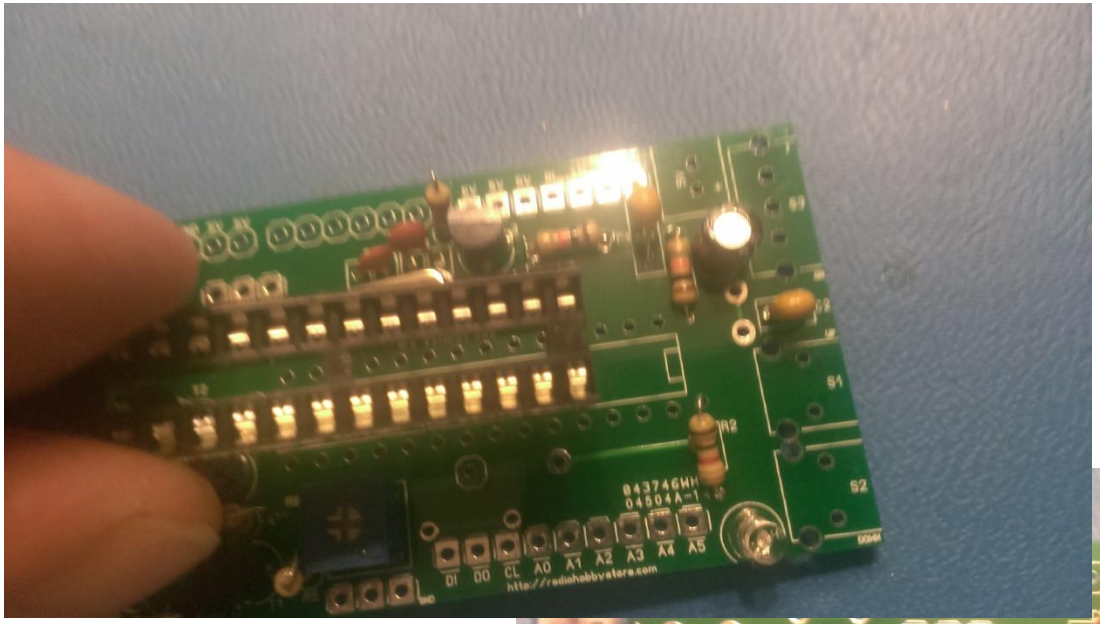
Phase 3 complete

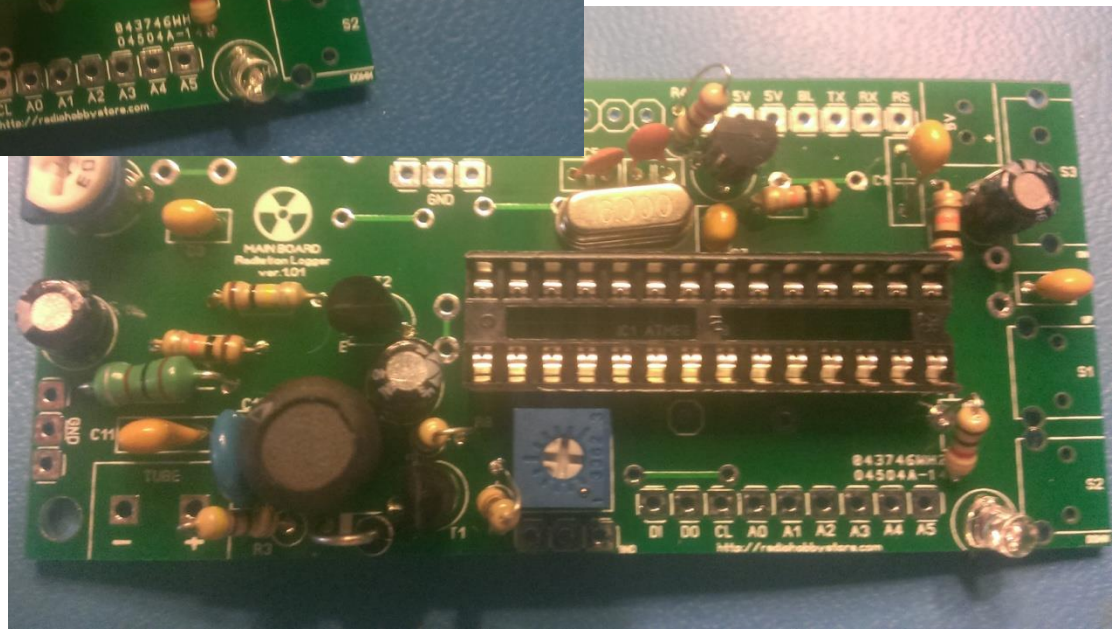


Phase 4

	Socket	1	DIP 28	IC socket
	S3	1	Slide Switch	On/Off switch
	Connector	1	Terminal Block	Tube connector
	S1, S2	2	Tact Switch	Up/Down Buttons
	Connector	2	6 Pin Female	LCD connector
	Connector	6 Pins	Male Right Angle	Peripheral connector

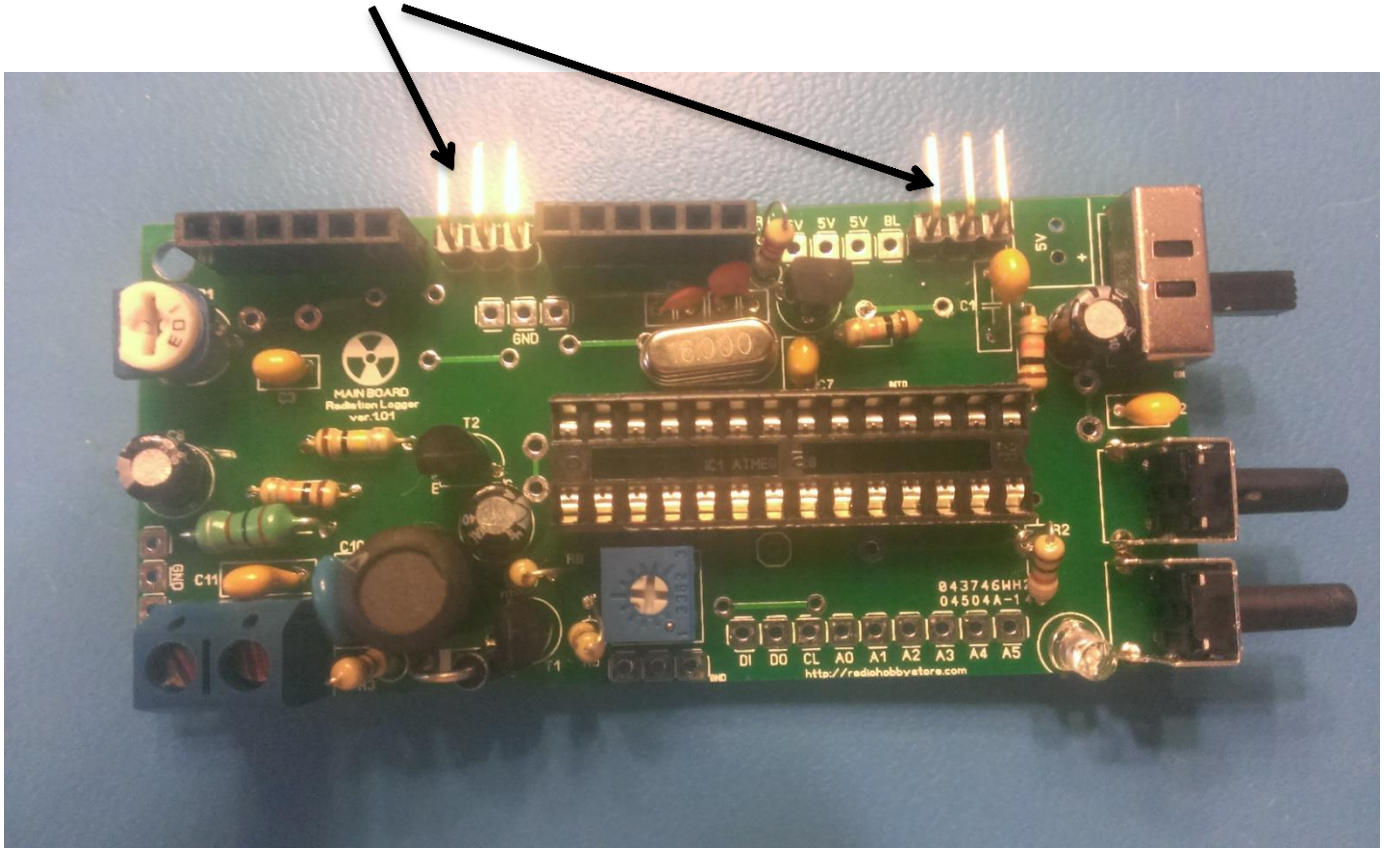
	Connector	20 Pins	Male	Peripheral connector
	Connector	1	Male	5V Connector
	Connector	12 Pins	Male Long	LCD Connector
	Standoff	2	M3 15mm	LCD Standoff
	Screw	4	M3 x6mm	LCD Screw
	LCD	1	16x2	HD44780 Green
	PCB	1	81x37 mm	Main Board



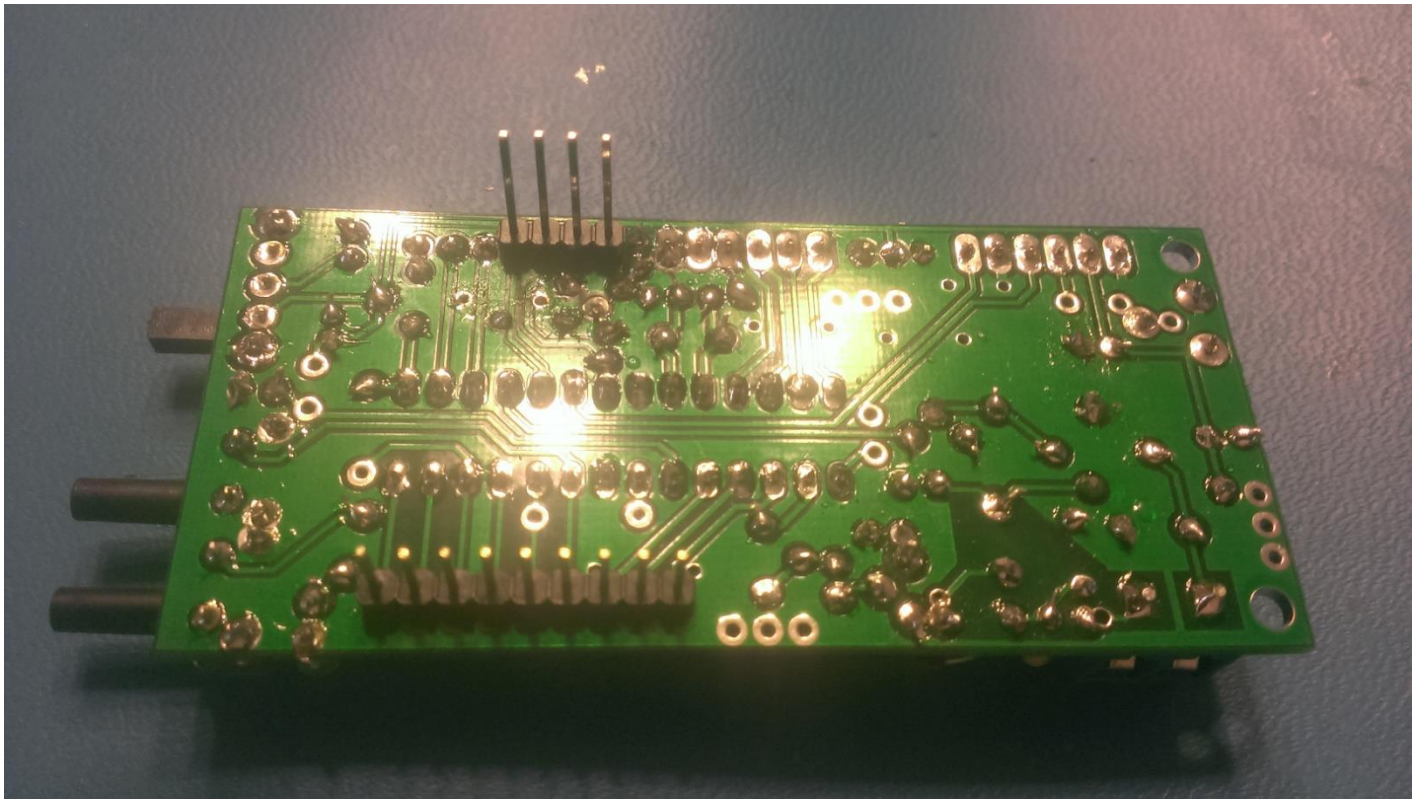


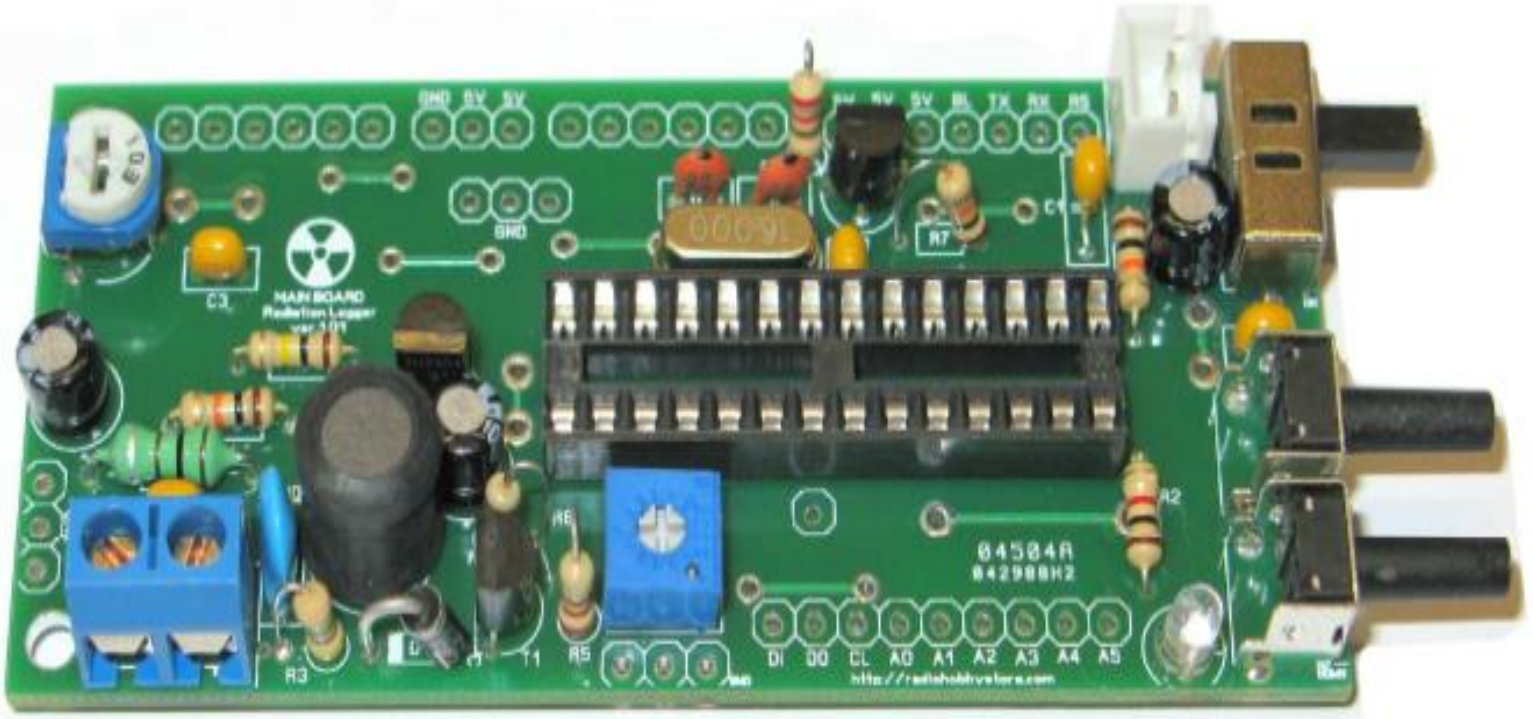
Carefully place the socket into the board, paying close attention to the diagram and where the indicator is.

Put the six pin female connectors in. Break the right angle connectors in half and place on either side of the female connector.



Solder in four male pins on one side of the board and nine on the other. Also, only use the short pins. Then long pins will be used later.

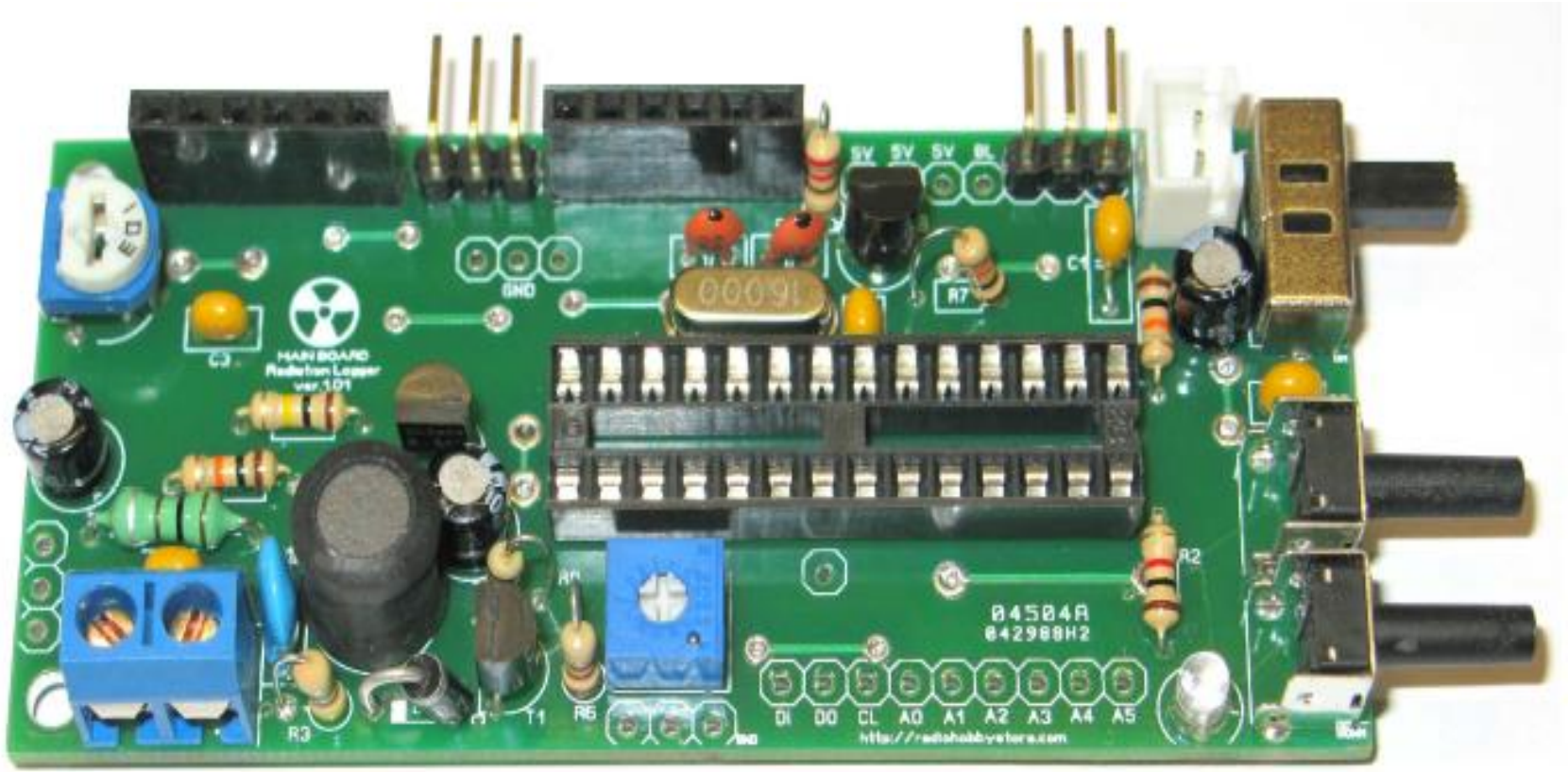




P1 is LCD contrast potentiometer. Trim it in anti-clockwise direction for adjusting display contrast.
P2 used for high voltage fine adjustment. It's recommended to trim it to the middle point and use software calibration for high voltage.

Electrolytic capacitors should be installed in proper polarity. All other capacitors are ceramic and don't have polarity.

2x6 pin female connectors for LCD are soldered on the pcb and 2x6 pin male pins soldered on LCD module.



Take note, ATMEGA pitch is toward buttons side! Wrong polarity may damage the chip!

Board 2

This board has more small components. Middle school teachers may want to do some pre-soldering.

This is a great way to grow your soldering skills.

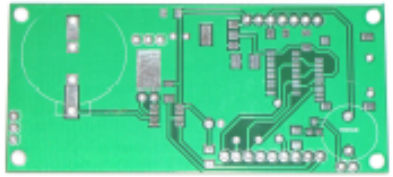
Take your time and remember you can always undo a solder.

Assembling of the SD Shield Board:

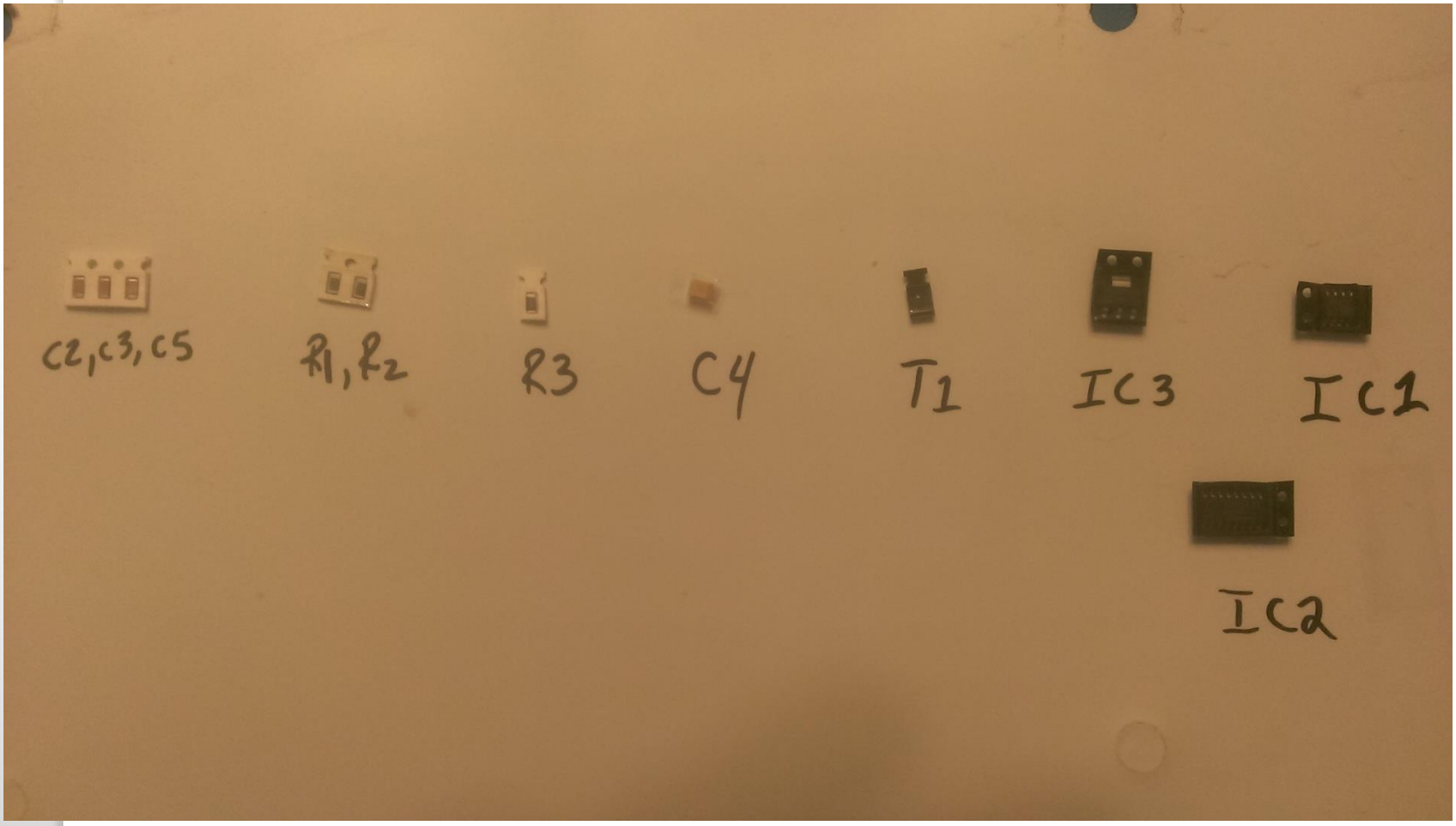
Before you start soldering the SD Shield board please follow components list table. SD-Board parts are SMT and require special skills for soldering. You can use hot air or solder with tiny tip. If you never soldered SMD parts before, we suggest you to read several guides, such as Sparkfun tutorial: https://www.sparkfun.com/tutorials/96
Some components has polarity, please refer electrical circuit, pcb silkscreen and physical photos from this manual!

Image	Name	Quantity	Value	Description
	R1, R2	2	2.2K ohm	1206 SMT resistor (222)
	R3	1	10K ohm	1206 SMT resistor (103)
	C2, C3, C5	3	100nF	1206 SMT capacitor
	C4	1	10uF	3528 SMT Tantalum
	C1	1	100uF	Electrolytic Capacitor
	T1	1	BC847	SMT Transistor sot-23

	IC3	1	ASM1117-3.3V	3.3V regulator sot-223
	IC1	1	DS1307	RTC soic-8
	IC2	1	74HC4050	Level Shifter soic-16
	Cr	1	32.768KHz	Crystal
	Socket	1	Micro SD socket	SMT
	Socket	1	CR1220 Holder	Battery Holder SMT

	Connector	2	3 Pin Female	Shield connector
	Connector	1	4 Pin Female	Shield connector
	Connector	1	6 Pin Female	Shield connector
	Buzzer	1	5V	Piezo Buzzer
	JMP1	1	Jumper	Buzzer Jumper
	Standoff	4	M3 11mm	Shield Standoff
	Screw	4	M3 x6mm	Shield Screw
	PCB	1	81x37mm	Shield Board

Label all components before beginning. This will make it easy to find the correct placement on the board.



Easiest order: 1st C1 and Cr

2nd SD Socket

(there are tabs to help align)

3rd C2, C3, C5

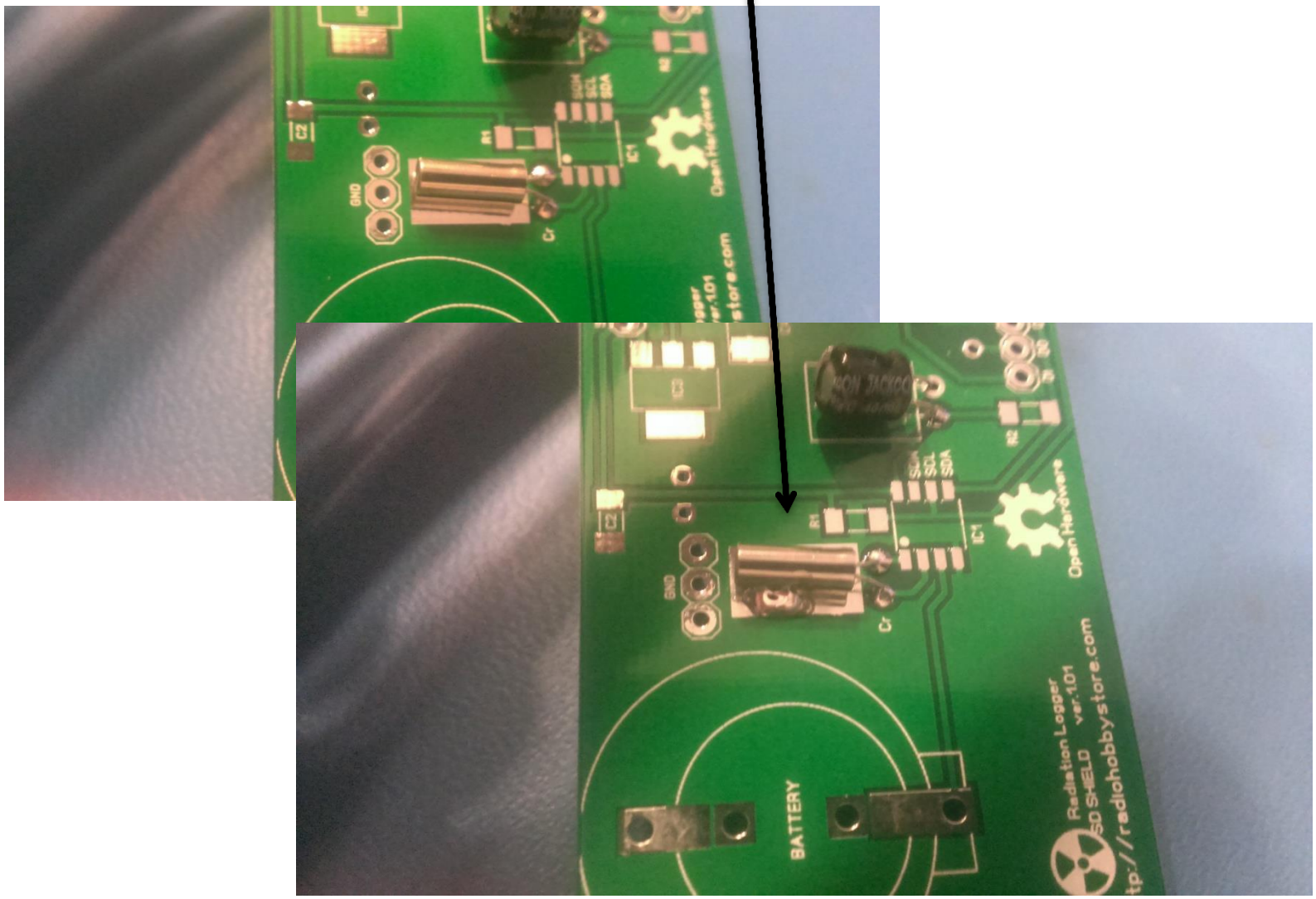
4th R1, R2, R3

5th T1, IC1, IC2, IC3

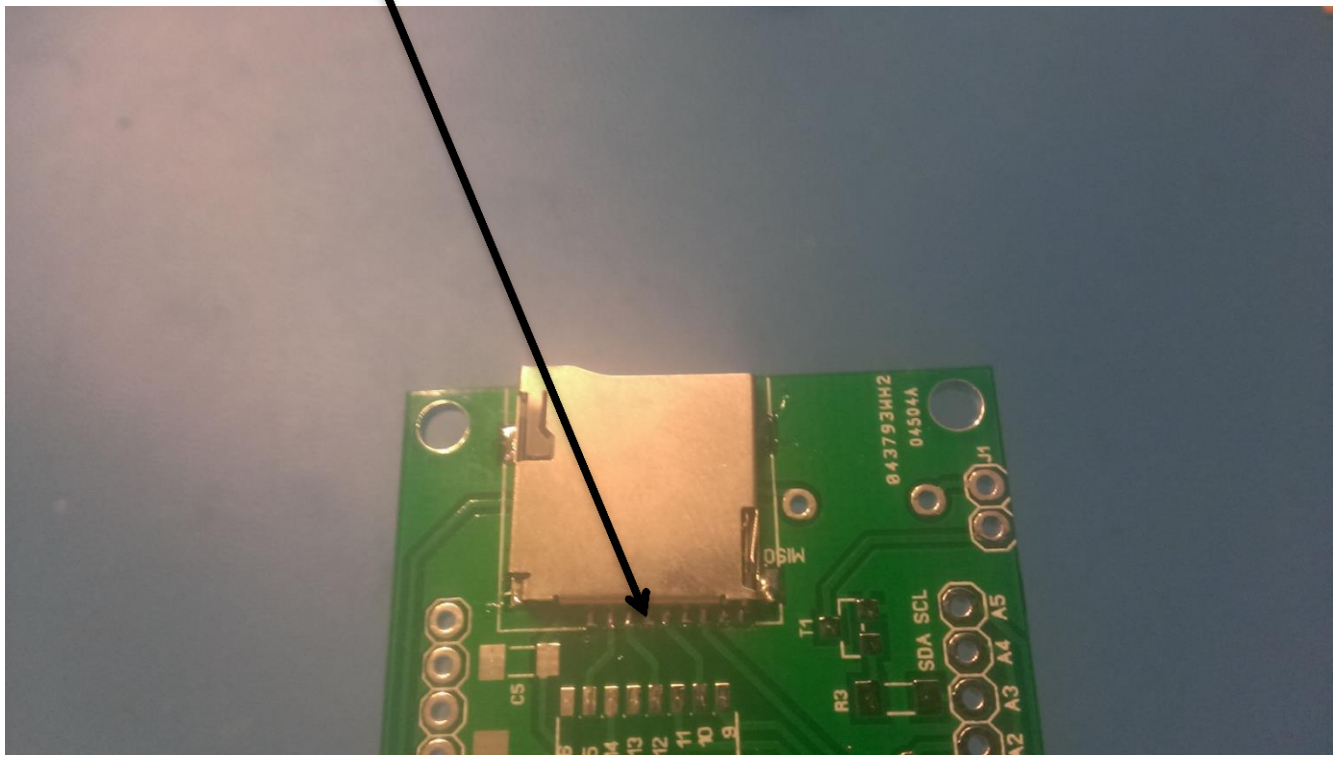
6th C4

7th Female connectors, buzzer, batter holder

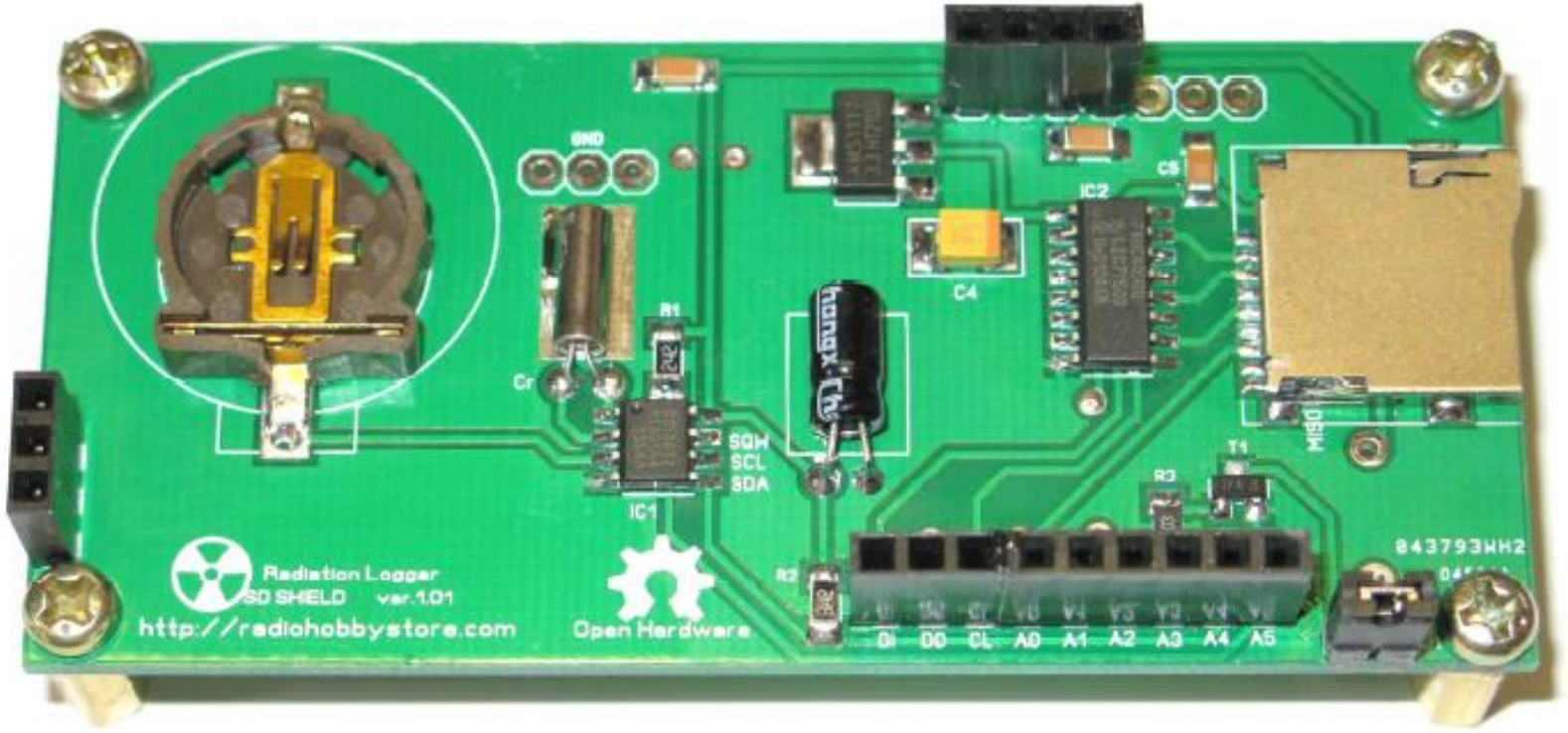
Cr will need to be soldered to the metallic tab.



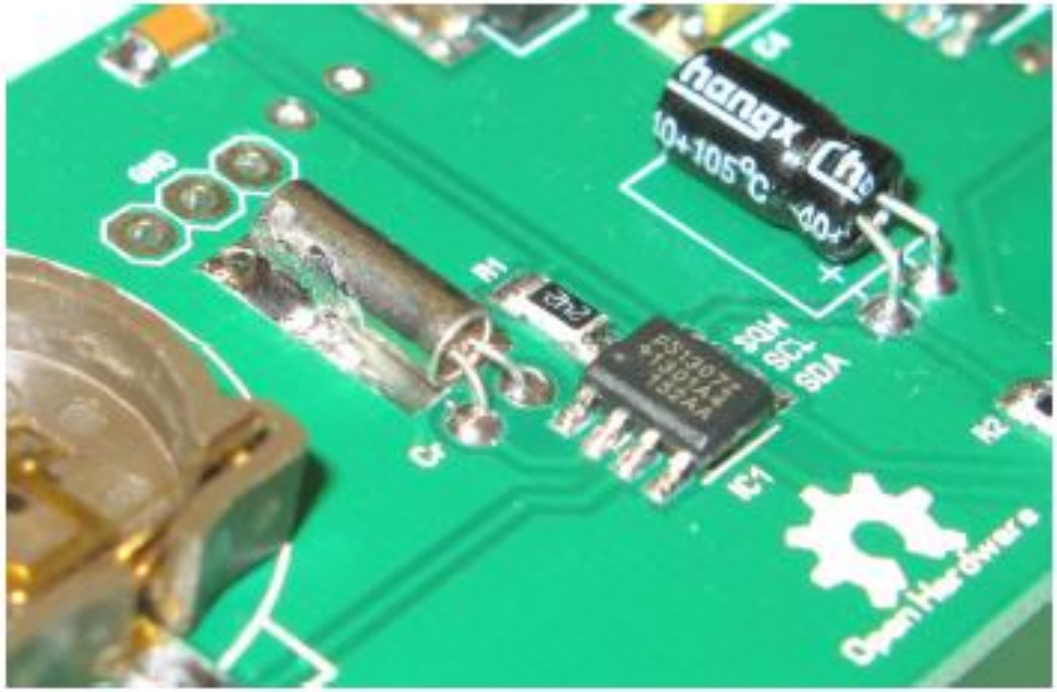
Pay close attention to not bride the SD socket leads. Very close together and a magnifying glass would be advised.

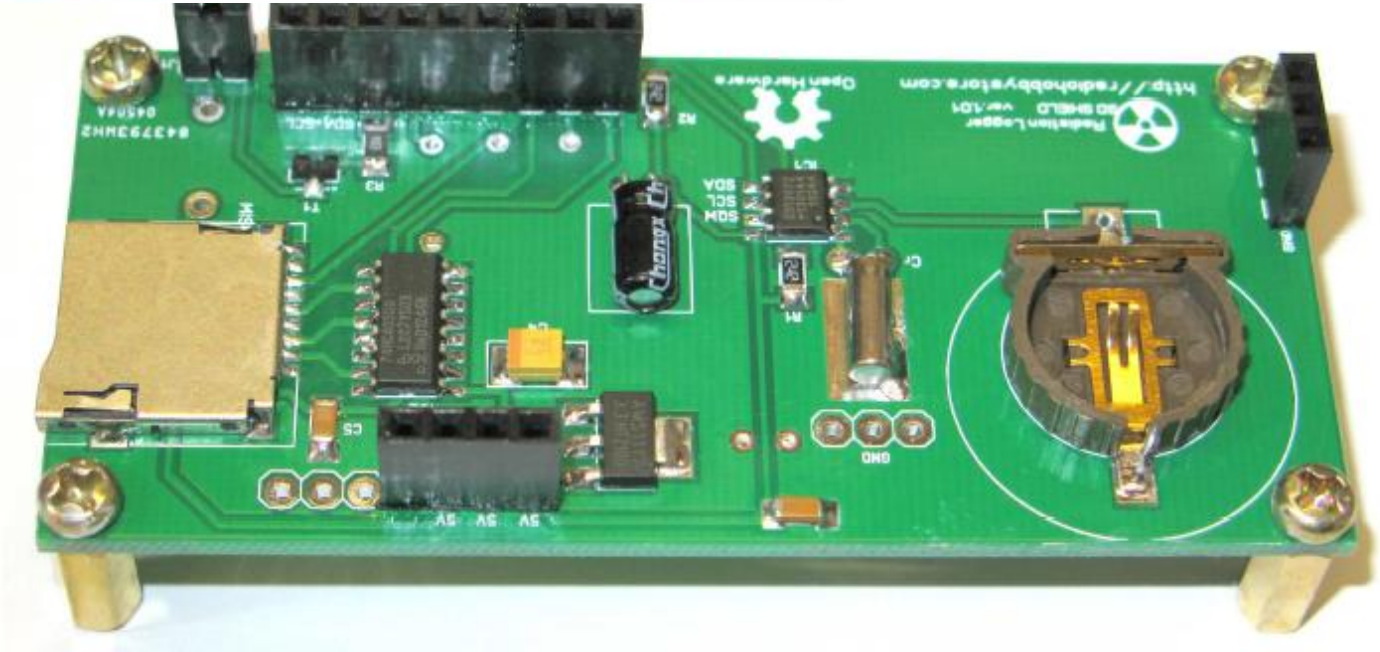


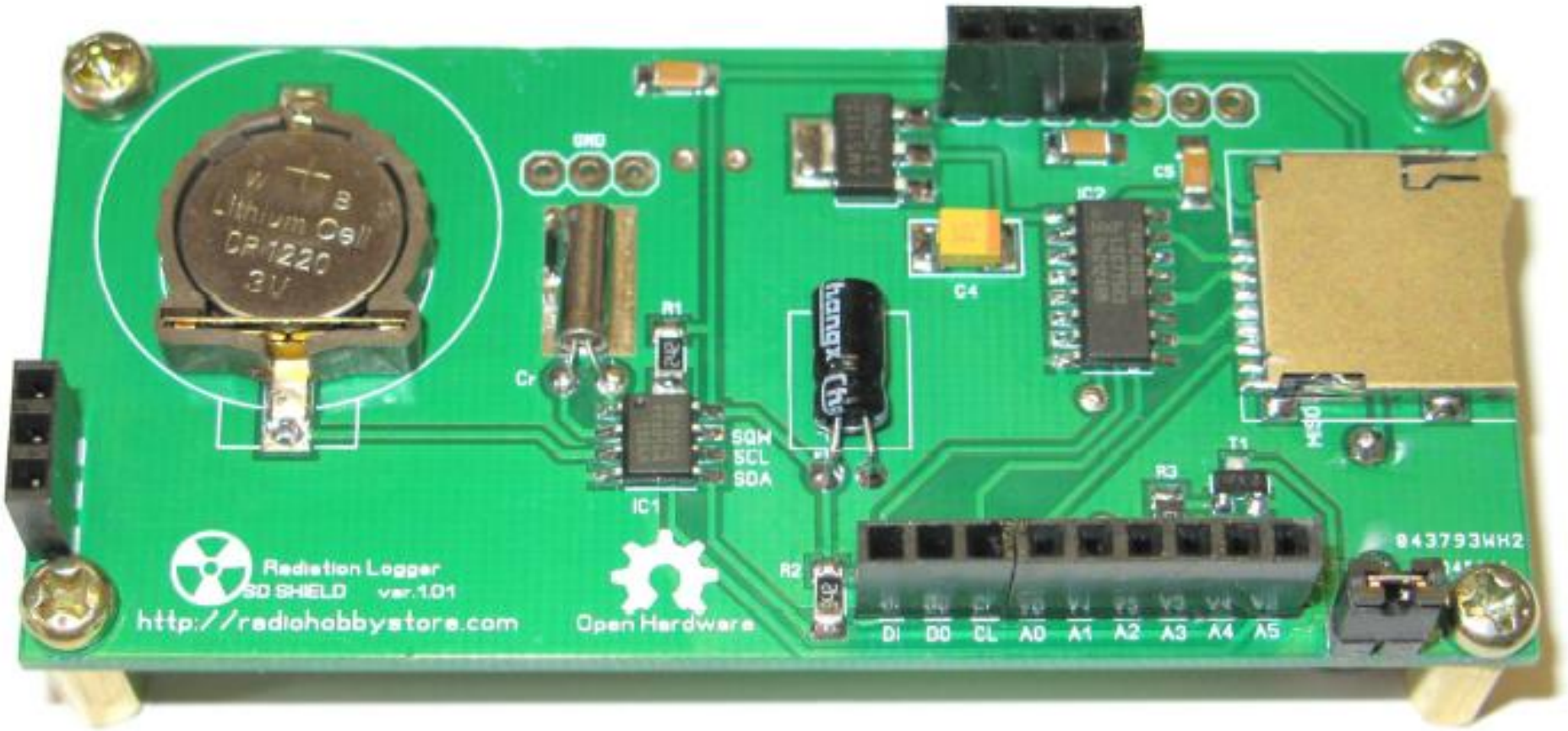
Use the order given as some components block the others. They are small but as long as you don't bridge the solder it is straight forward.



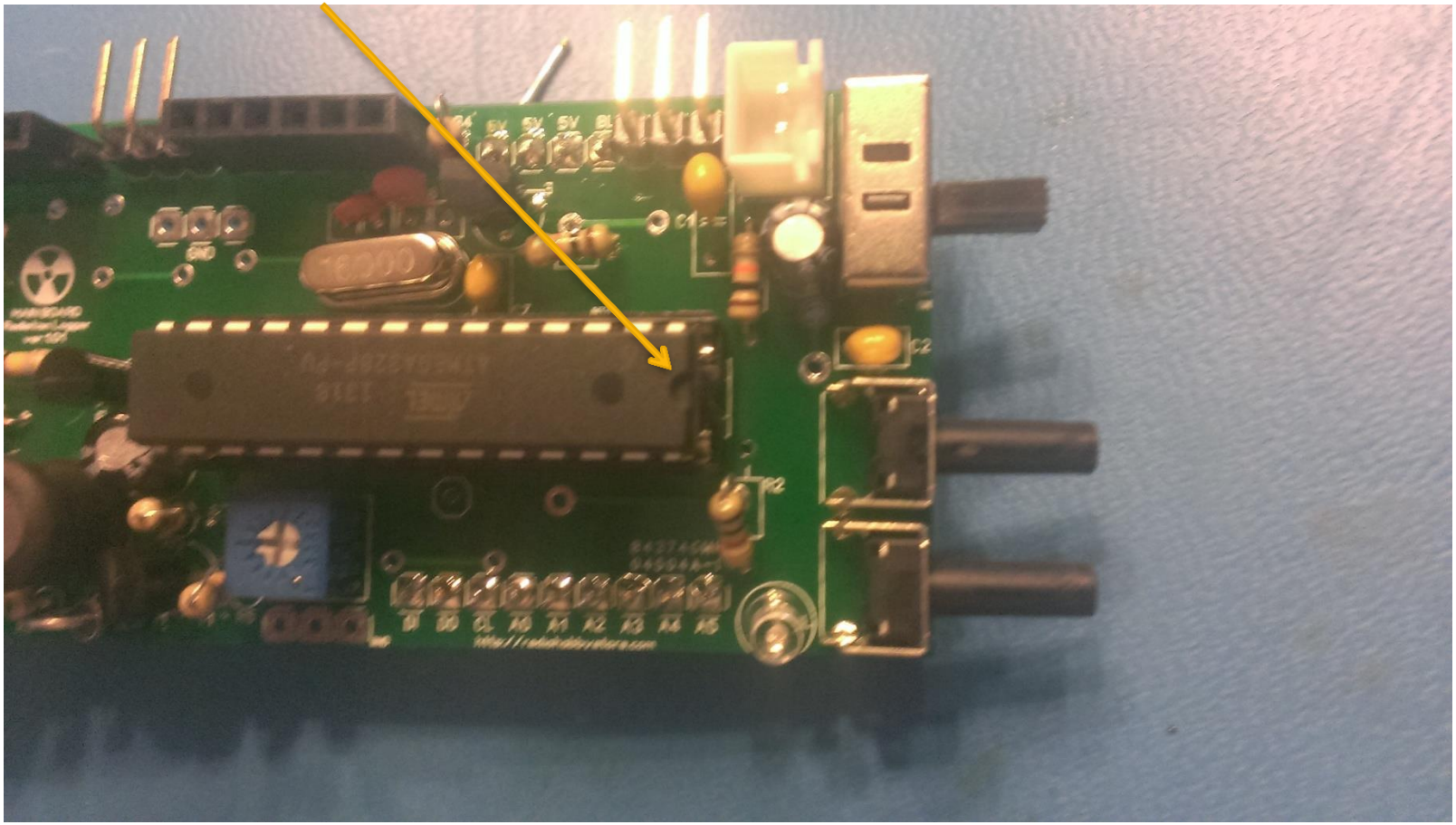
For RTC stability, crystal has to be soldered with point to ground plane. Do not overheat the crystal!

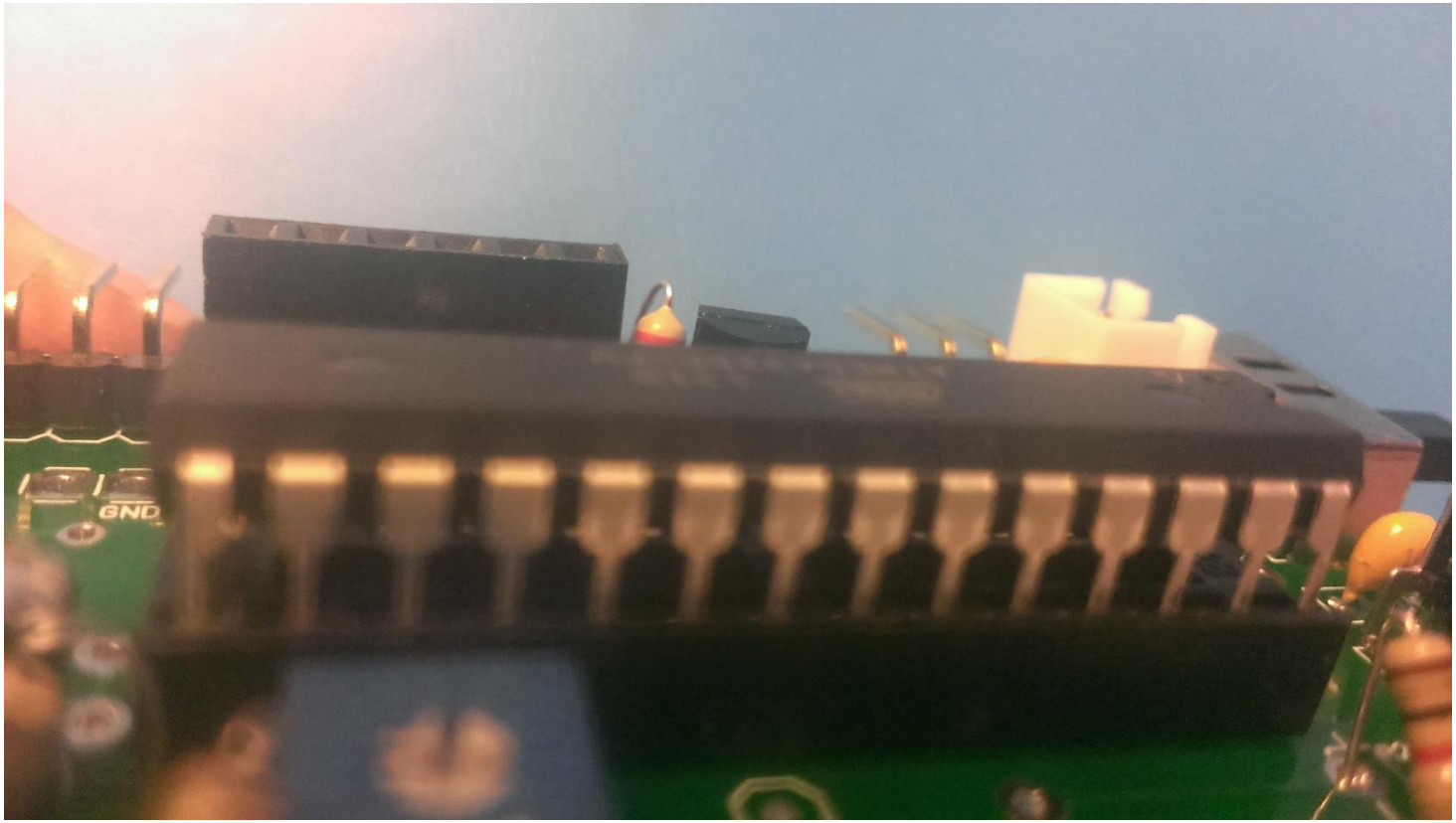

hangx
105°C
Open Hardware


Radiation Logger
SD SHIELD ver.1.01
http://radiohobbystore.com
Open Hardware
SDA
SCL
GND
5V

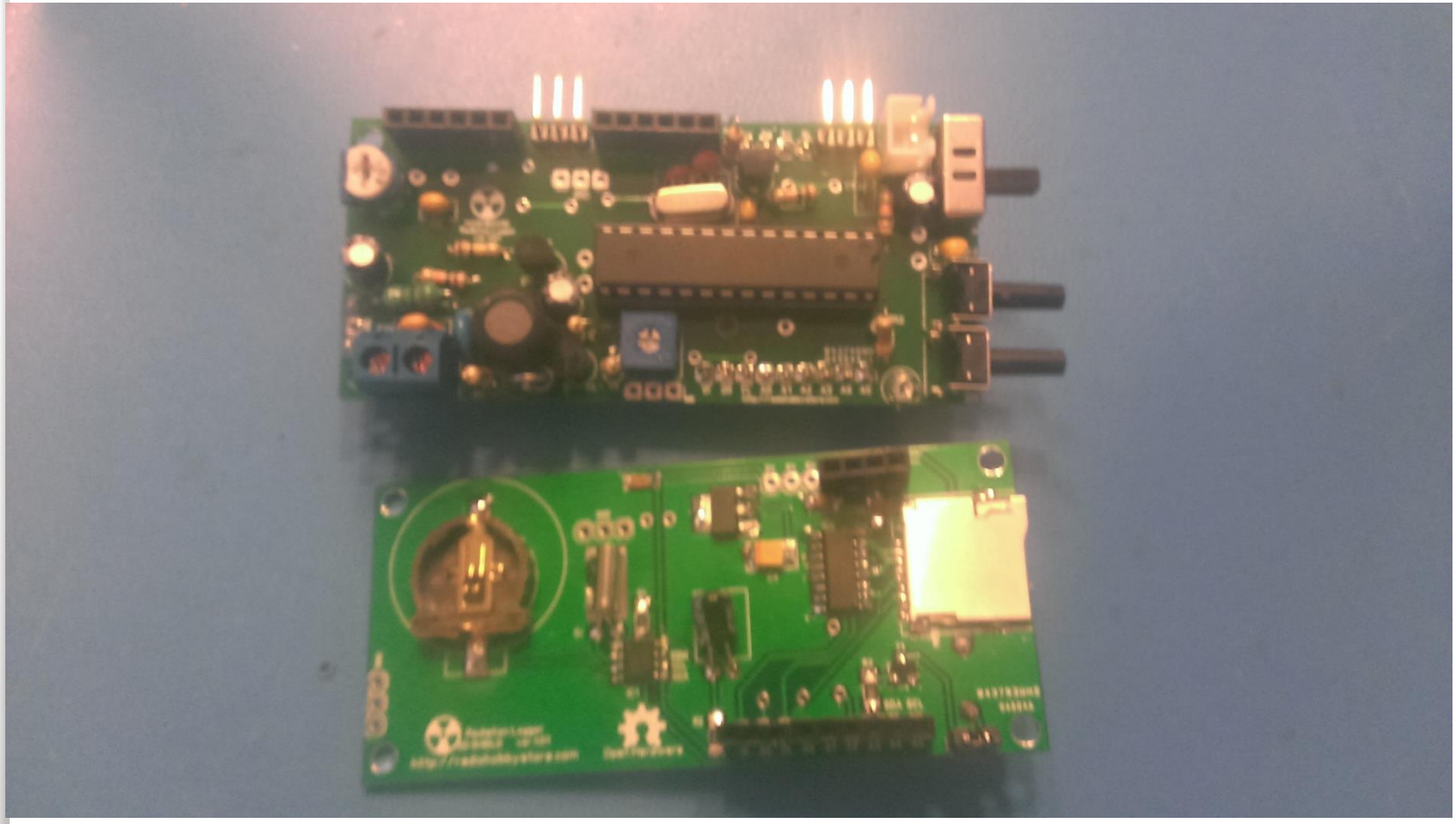

Lithium Cell
CR1220
3V
GND
R1
Cr
SQW
SCL
SDA
IC1
IC2
C4
C5
T1
R3
R2
Radiation Logger
SD SHIELD ver.1.01
http://radiohobbystore.com
Open Hardware
DI DO CL A0 A1 A2 A3 A4 A5

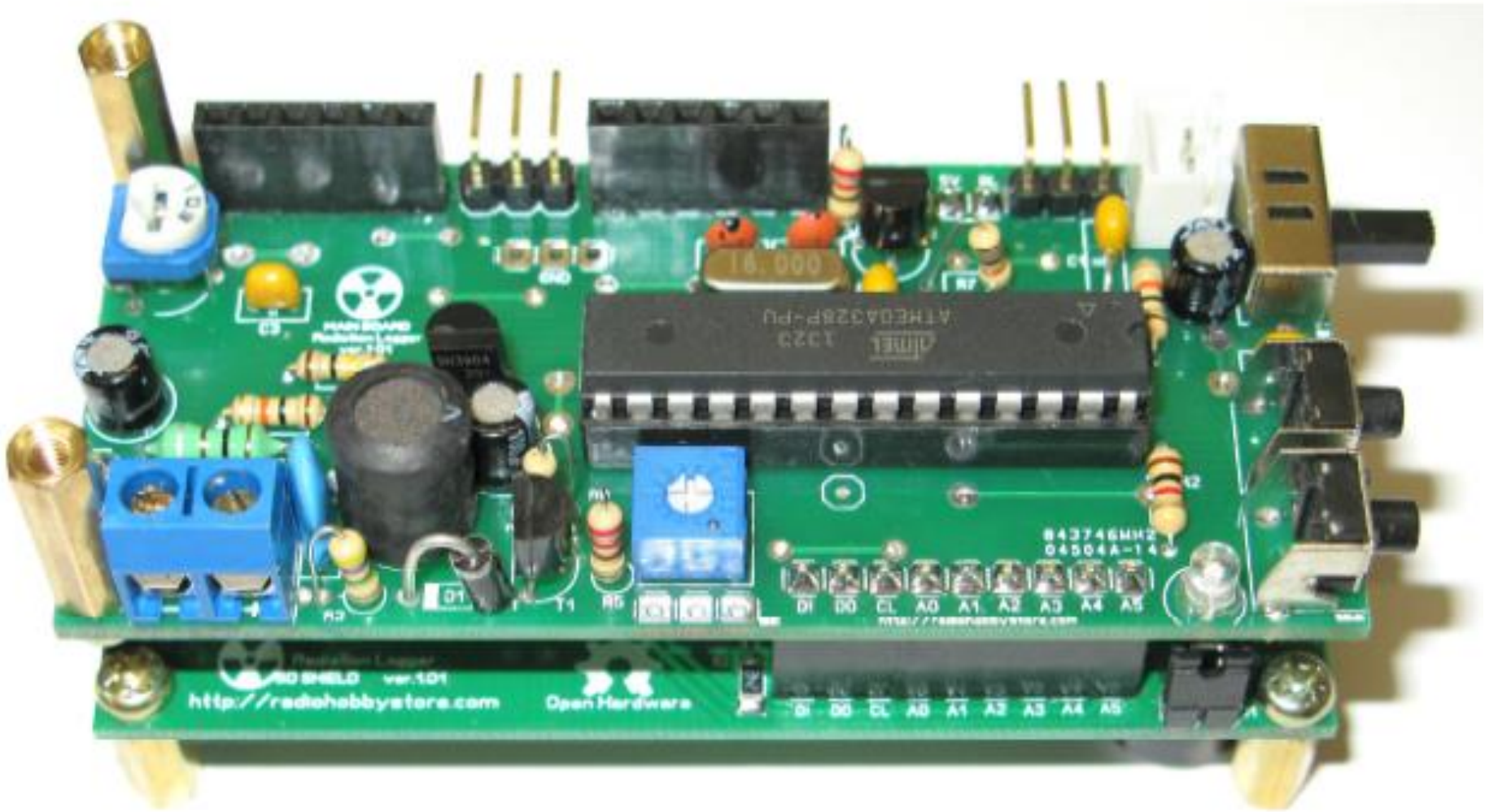
Now place the memory chip on board1. Be careful not to bend the pins, evenly and slowly press down on the chip. Pay close attention to the orientation.




GND

Now that all three boards are complete we will connect them. The long male pins will be used between the Arduino board and board 1. Short male pins between board 2 and 3.




http://radiohobbystore.com
Open Hardware
DI DO CL A0 A1 A2 A3 A4 A5

Programming

Suggested that you already know how to upload sketch. Please do following steps:

1. Install Arduino IDE.
2. Install all libraries from supplied lib.zip
3. Install USB-TTL drivers for your adapter.
4. Open IDE, select Tools→Board→Arduino UNO. Select Tools→Programmer→AVRISP mk)I. Set COM port where you connected your USB-TTL adapter.
5. Install RTC CR2110 battery.
6. Connect the board as picture below shows.
7. Open RTCsetup.ino, set your date and time and upload it into the board.
8. Open Geiger.ino, modify parameters if required and upload it into the board.
9. Disconnect the board from the computer and install micro SD card.

To upload sketch please connect USB-TTL adapter as shown on the picture. You can use a low cost CP2102 adapter with DTR pin. Atmega-328 comes with pre-loaded Arduino UNO bootloader that makes logger firmware updates extremely easy even for beginners through Arduino IDE. DTR pin should be connected to allow digital reset be processed for firmware upload.

How to install Arduino IDE:

Please download the latest IDE from http://arduino.cc Navigate to "Download" section and select file for your OS. You can find general guides about how to use the IDE functions, for example Windows user can look here: http://arduino.cc/en/Guide/Windows If you never used Arduino before, please take your time and read general guides first! You do not have to learn all, but the basic things.

How to install libraries:

Very important to use supplied libraries, otherwise you'll not be able to compile and upload the firmware. Please un-zip lib.zip into Arduino libraries folder or read here:
http://arduino.cc/en/Guide/Libraries

Which USB-TTL adapter to use:

Required module with Digital-Reset function (DTR pin), for example CP2102 is a cheap one can be found on http://ebay.com Take note, some modules sold on ebay are fakes or missing DTR pin, please confirm with a seller about the model you buy.

What do I need to modify in RTCsetup.ino:

You need to set your date and time and upload the sketch immediately. Please read program comments text. For example to set the 16:45:00 01/01/2014 I need to modify it like this:

```
RTC.set(DS1307_SEC,0);        //set the seconds
RTC.set(DS1307_MIN,45);       //set the minutes
RTC.set(DS1307_HR,16);        //set the hours
RTC.set(DS1307_DOW,3);        //set the day of the week
RTC.set(DS1307_DATE,1);       //set the date
RTC.set(DS1307_MTH,1);        //set the month
RTC.set(DS1307_YR,14);        //set the year
```

Which backup battery for RTC to use:

CR1220 battery by default, but you also can use CR2032 (required different holder). After you upload RTC setup sketch do not remove the battery!

What do I need to modify in geiger.ino:

Please read comments! Scroll down to load parameters section:

```
//---------------- load parameters--------------------//
#define RAD_LOGGER   true       // enable serial CPM logging to computer for "Radiation Logger"
#define GPS          false      // enable GPS on Serial Port
.....
```

By default the sketch comes with GPS support turned OFF (false). If you do not use GPS module then turn ON Radiation Logger serial output

```
#define RAD_LOGGER   true
```

What can I modify in geiger.ino?

Mostly depend on your programming skills. Some users will make software redesign and some user will only change tube conversion factor. Please read comments in software. It will help you to identify code purpose for different parts of the program. You are free to modify the program for your consideration. Please remember when doing any changes that you are responsible for any modifications you make. The code provided as is and mostly for people who like to configure the hardware.

How to check and calibrate high voltage:

The point here that you cannot measure high voltage with a regular voltmeter directly. It will overload the circuit because of low internal resistance of the voltmeter. Usually digital voltmeters has 1M or 10M internal resistance. That's why you need to use high impedance voltage divider. 1Giga ohm resistor is an ideal tool for this purpose (Mouser Part #: 588-SM106031007FE or similar). You need to connect your multimeter in series with 1Giga ohm resistor and calculate high voltage reading with following formula:

$$Vout = Vread^* ((Rdivider + Rvoltmeter)/Rvoltmeter)$$

Where Vout is high voltage output, Vread is voltage you read on your voltmeter display, Rdivider is 1000M ohm, Rvoltmeter is your voltmeter internal resistance(1M or 10M). For example 404V after 1G divider with 10M multimeter will read as 4V.

$$404V = 4V^*((1000+10)/10)$$

In case you cannot find 1G resistor you can use 100M divider, connect 10x 10M 1% resistors in series.

The optimum voltage for SBM-20 tube is 400V. You also can run the tube without any problem on 380V or 420V, there is no difference for tube sensitivity.

To calibrate your board high voltage, please power it with 5V and measure high voltage output when P2 is trimmed to middle position. If you read less than 380V or more than 425V then you'll need to adjust the software settings for high voltage. Open geiger.ino and find Configurator.h tab.
The following code is control PWM functions:

```
// PWM starting points, valid only for 400V without voltage multiplier!
#define PWM_FUL  100     // pwm settings for different battery levels
#define PWM_MID  105
#define PWM_LOW 110
#define PWN_FREQ 8      // PWM frequency setup
```

PWM_FUL, PWM_MID and PWM_LOW it's the values you should change here. If you read lower than 380V try to increase PWM values with 5 points step. If you read higher than 425V try to decrease this numbers. Remember that all things connected together.

How to connect Adafruit GPS Module:

Before using GPS module you need to switch the software option in sketch and re-upload the sketch with GPS support turned ON.

```
//---------------- load parameters--------------------//
#define RAD_LOGGER   false       // enable serial CPM logging to computer for "Radiation Logger"
#define GPS                true       // enable GPS on Serial Port
.....
```

Connect GPS module to RX, TX pins. Adafruit module can be powered from the kit 5V pin. Take note, GPS will consume additional 20mA from the battery.

Other GPS modules compatibility:

Currently software support only Adafruit GPS module http://www.adafruit.com/products/746

You can modify nmeaToGPS() function by yourself to initialize different GPS modules.

Why GPS not perform FIX:

GPS module requires open field condition. Set GPS antenna to sky direction.

How to prepare micro SD card:

You need to format the card before usage. Please follow Adafruit formatting guide here:

http://learn.adafruit.com/adafruit-micro-sd-breakout-board-card-tutorial/format

Download SD Formatter software https://www.sdcard.org/downloads/formatter_4

Do not format with default Windows tool! When using card-reader insert or remove the card only then card-reader disconnected from USB! In the same way, insert or remove card only then the kit is powered off!

How to power the kit:

The kit's hardware needs 4.6V-5.4V to operate. There is several options for powering the kit, please consider the best for you.

1. 4x AA 1.2V Ni-MH rechargeable batteries, 1800mAh or higher.
2. 2x AA 1.5V Alkaline batteries with 5V step-up module.
3. 3.7V LiPO battery with 5V step-up module, 1000mAh or higher.
4. 5V DC regulated power supply for indoor.

Powering the board with voltage over 5.50V or with wrong polarity may damage the components!

Power consumption of the kit is about 20-22mA. LCD backlight require additional 8-10mA, but because the software use smart backlight control, most of the time LCD backlight is powered off for saving battery.

Battery indicator on LCD will inform you if capacity of the battery is half or low. Take note, battery indicator works correctly only with Ni-MH type. When using step-up modules battery indicator may be ignored or commented through software.

5V step-up module consumes additional current from the battery, depend on the module performance. **NCP1402** Pololu or Sparkfun 5V step-up modules are excellent for this kit, but also no-name eBay modules may work perfect.

Compatible Geiger Tubes:

The kit has wide tubes compatibility. To convert CPM (count per minute) to uSv/h the software uses conversion factor. Usually it's known value from GM tube datasheet. Look at the factor settings code section and modify if other than SBM-20 tube is used.

```
// GM Tube setting
#define FACTOR_USV 0.0057    // Sieverts Conversion Factor, known value from tube datasheet
/*
SBM-20   0.0057
SBM-19   0.0021
SI-29BG  0.0082
SI-180G  0.0031
J305     0.0081
SBT11-A  0.0031
SBT-9    0.0117
*/
```

This values are not something absolute because each tube has about 10%-20% cpm tolerance. But for amateur purposes setting the default value for your tube is enough.

Logging to computer with "Radiation Logger"

The kit allows you to log CPM values to your computer hard-disk with "Radiation Logger". Download our freeware application for Windows here:

http://www.rhelectronics.net/store/radiation-logger.html

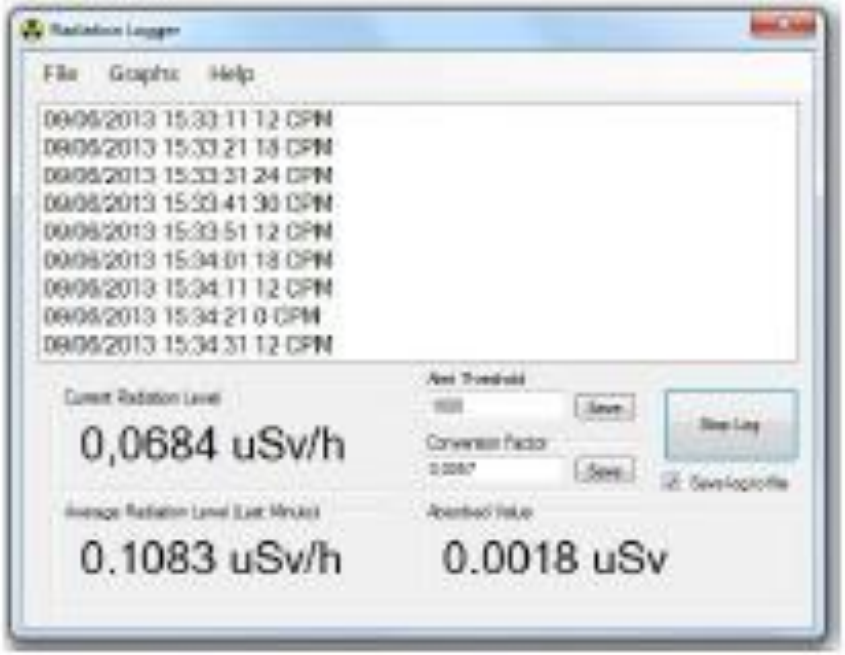
To connect the kit to your computer you'll need USB-TTL dongle adapter. You can use same adapter you have used for uploading the sketch or any other adapter with RX, TX, 5V and GND pins.

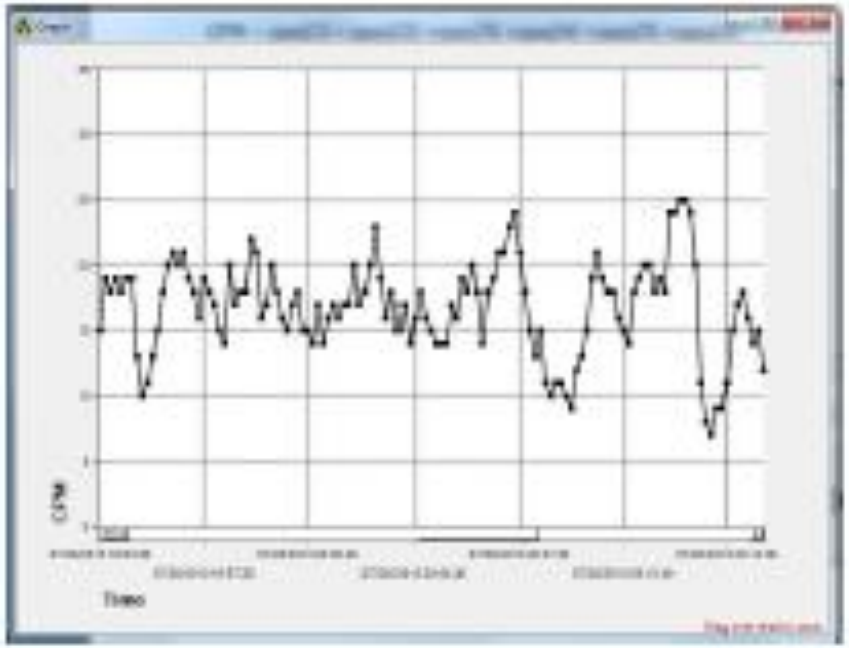
Use 9600 baud rate speed 8N1 settings for COM port. The logger will safe csv log files on your harddrive with system time and CPM value. The files can be used for building graphs or comparing different measurements later.

With "Radiation Logger" you can log simultaneously to http://radmon.org and to your personal feed on http://xively.com Connection settings are very simple.

```
//---------------- load parameters-------------------//
#define RAD_LOGGER   true       // enable serial CPM logging to computer for "Radiation Logger"
#define GPS          false      // enable GPS on Serial Port
.....
```

When using "Radiation Logger", the kit can draw power from the computer and it very important to set power switch to OFF to disconnect the batteries!

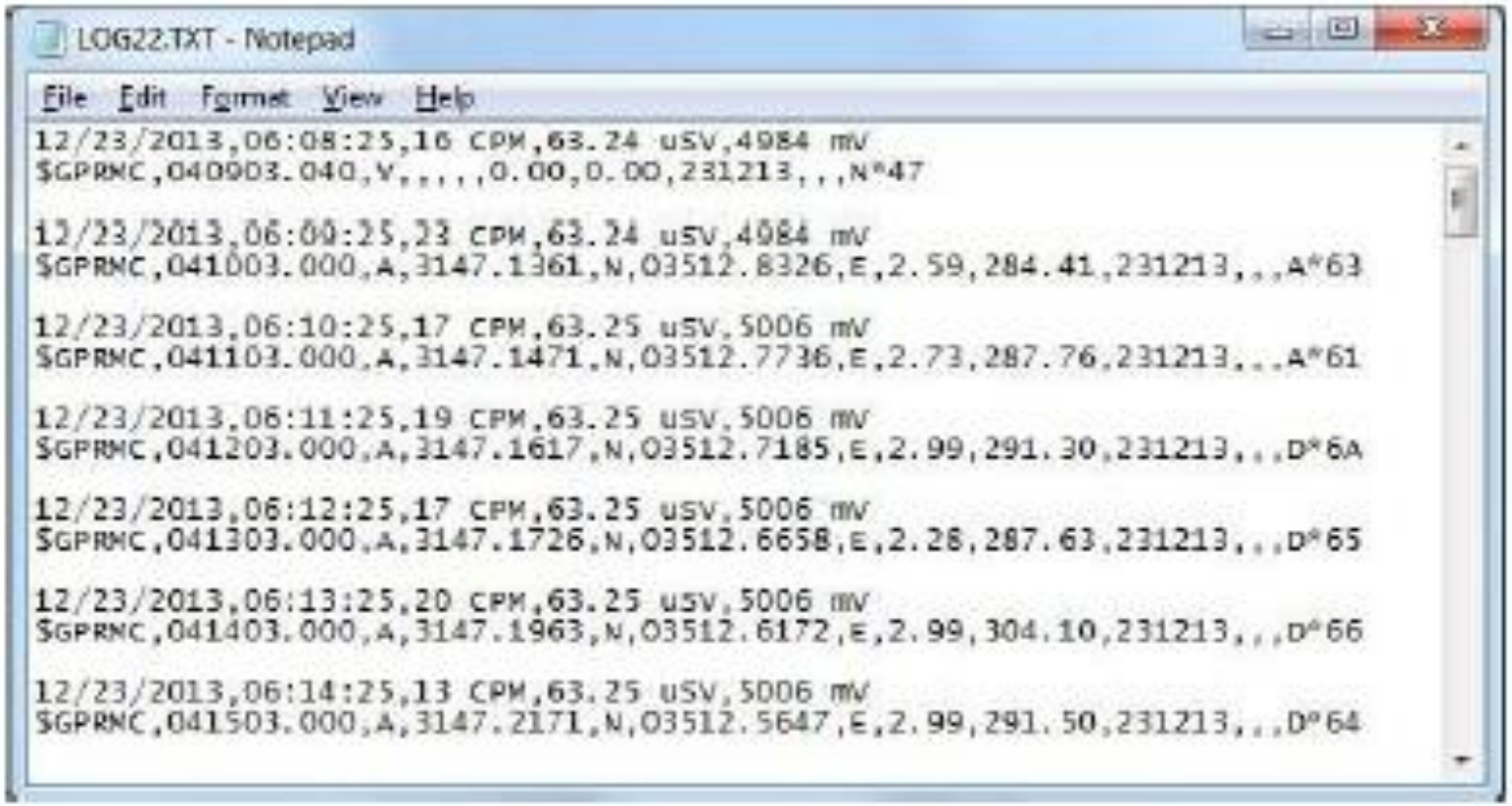

Radiation Logger
File
Graphic
Help
09/06/2013 15:33:11 12 CPM
09/06/2013 15:33:21 18 CPM
09/06/2013 15:33:31 24 CPM
09/06/2013 15:33:41 30 CPM
09/06/2013 15:33:51 12 CPM
09/06/2013 15:34:01 18 CPM
09/06/2013 15:34:11 12 CPM
09/06/2013 15:34:21 0 CPM
09/06/2013 15:34:31 12 CPM
Current Radiation Level
0,0684 uSv/h
Conversion Factor
Average Radiation Level (Last Minute)
0.1083 uSv/h
Absorbed Value
0.0018 uSv


CPM
Time

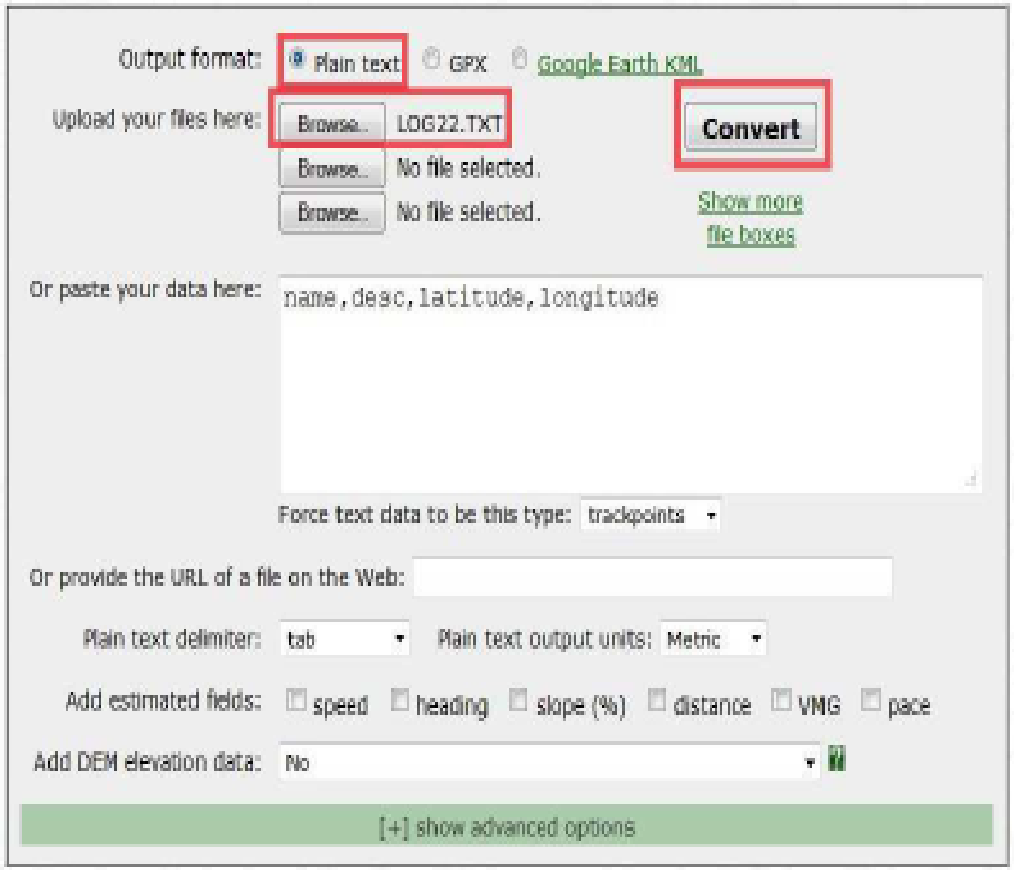
How to work with LOG.TXT and GPS data file:

Many thanks to great online tool available on http://www.gpsvisualizer.com You can use LOG.TXT file to create google map with Geiger data you want to be presented. Here is the example. Part of the work done by auto and part of the work you need to do manually. Online GPS tool uses UTC time format from GPS data and not your local time, please take note when you edit CSV table.

Copy LOG.TXT file you want to work with from SD to your computer. When you open it with notepad you'll see that it contains different information, such as:



Now we need to convert this file to something that gpsvisualizer website can work with. Browse to "Convert a GPS file to plain text" online tool http://www.gpsvisualizer.com/convert?force_type=t



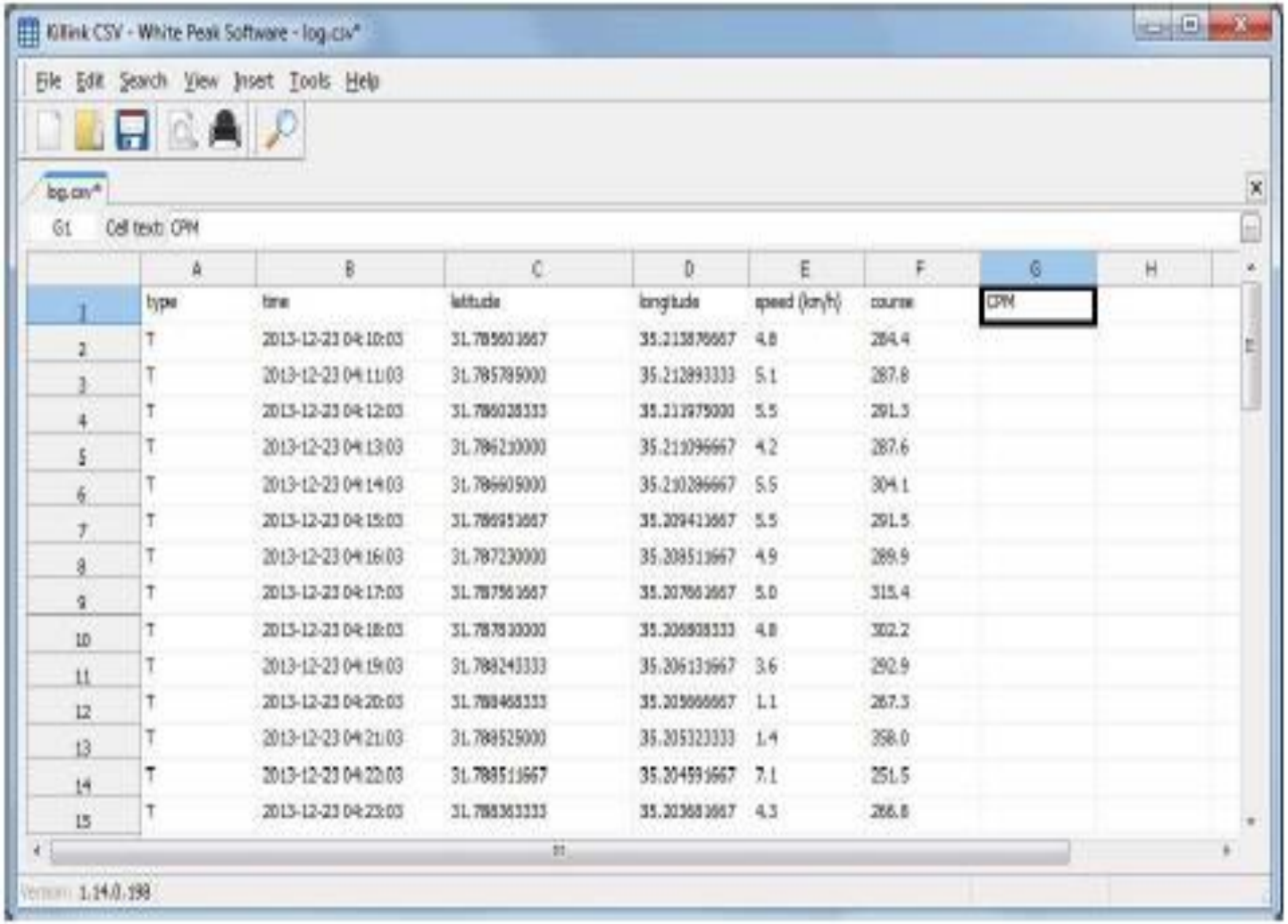
You'll get a similar screen when you can just copy-paste the table into your favorite CSV editor.

The contents of your file are also displayed in this box, if you'd rather cut and paste:

type	time	latitude	longitude	speed (km/h)	course	name	
T	2013-12-23	04:10:03	31.785601667	35.213876667	4.8	284.4	LOG22
T	2013-12-23	04:11:03	31.785785000	35.212893333	5.1	287.8	
T	2013-12-23	04:12:03	31.786028333	35.211975000	5.5	291.3	
T	2013-12-23	04:13:03	31.786210000	35.211096667	4.2	287.6	
T	2013-12-23	04:14:03	31.786605000	35.210286667	5.5	304.1	
T	2013-12-23	04:15:03	31.786951667	35.209411667	5.5	291.5	
T	2013-12-23	04:16:03	31.787230000	35.208511667	4.9	289.9	
T	2013-12-23	04:17:03	31.787561667	35.207661667	5.0	315.4	
T	2013-12-23	04:18:03	31.787810000	35.206808333	4.8	302.2	
T	2013-12-23	04:19:03	31.788243333	35.206131667	3.6	292.9	
T	2013-12-23	04:20:03	31.788468333	35.205666667	1.1	267.2	

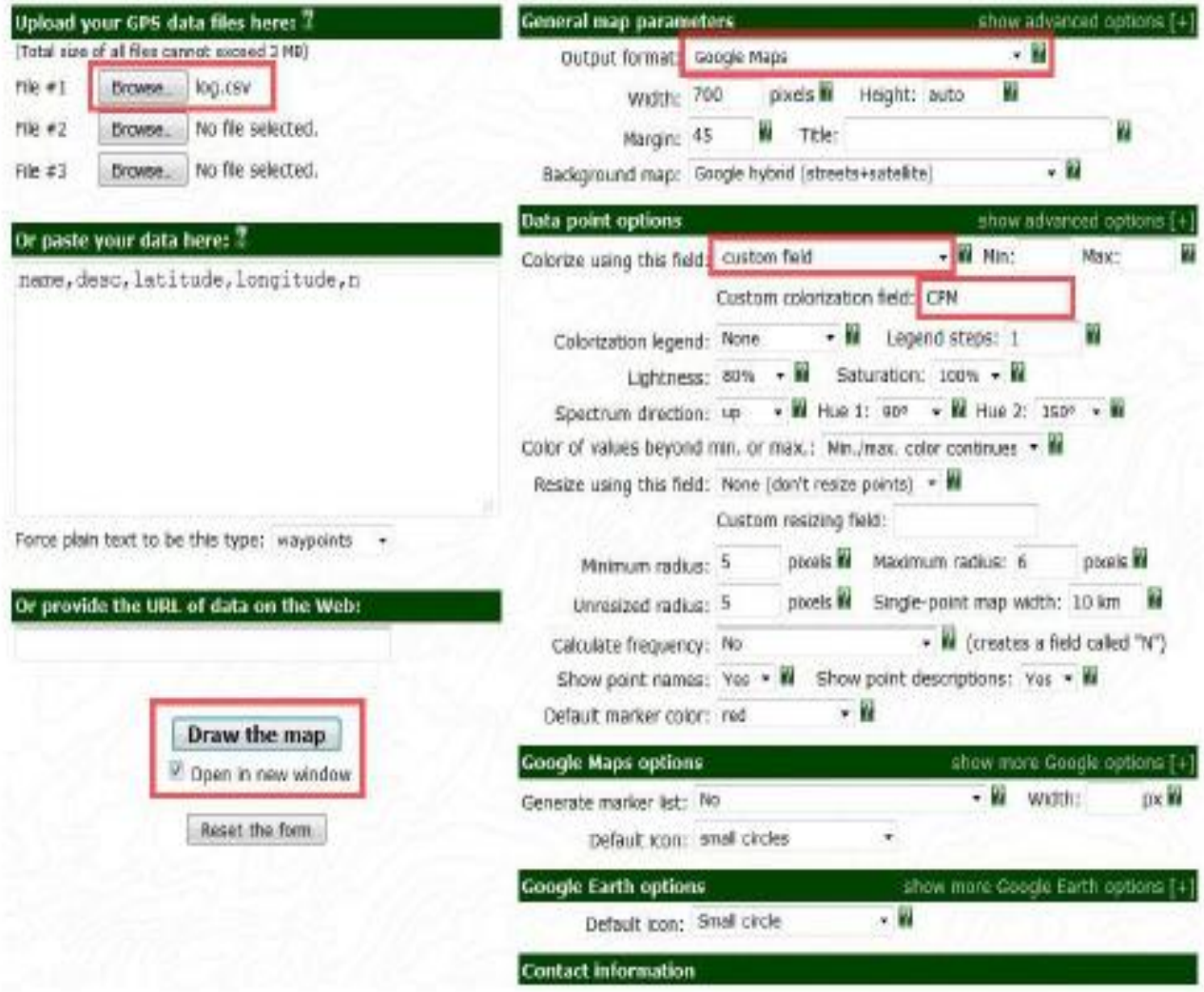
Map this data: Google Maps, Google Earth, JPEG map, SVG map, or elevation profile -- or go to the **map form** to set options

Add additional parameter you need, for example the CPM field.



	A	B	C	D	E	F	G	H
1	type	time	latitude	longitude	speed (km/h)	course	CPM	
2	T	2013-12-23 04:10:03	31.785603667	35.213870667	4.8	284.4		
3	T	2013-12-23 04:11:03	31.785785000	35.212893333	5.1	287.8		
4	T	2013-12-23 04:12:03	31.786028333	35.211975000	5.5	291.3		
5	T	2013-12-23 04:13:03	31.786210000	35.211096667	4.2	287.6		
6	T	2013-12-23 04:14:03	31.786605000	35.210286667	5.5	304.1		
7	T	2013-12-23 04:15:03	31.786951667	35.209411667	5.5	291.5		
8	T	2013-12-23 04:16:03	31.787230000	35.208511667	4.9	289.9		
9	T	2013-12-23 04:17:03	31.787561667	35.207661667	5.0	315.4		
10	T	2013-12-23 04:18:03	31.787810000	35.206808333	4.8	302.2		
11	T	2013-12-23 04:19:03	31.788240333	35.206131667	3.6	292.9		
12	T	2013-12-23 04:20:03	31.788468333	35.205666667	1.1	267.3		
13	T	2013-12-23 04:21:03	31.788525000	35.205123333	1.4	358.0		
14	T	2013-12-23 04:22:03	31.788511667	35.204591667	7.1	251.5		
15	T	2013-12-23 04:23:03	31.788363333	35.203681667	4.3	266.8		

With hard manual editing enter CPM value for each data point to this file. Browse to online Data Plot tool here: http://www.gpsvisualizer.com/map_input?form=data


Upload your GPS data files here:
(Total size of all files cannot exceed 2 MB)
File #1 Browse... log.csv
File #2 Browse... No file selected.
File #3 Browse... No file selected.
Or paste your data here:
name,desc,latitude,longitude,n
Force plain text to be this type: waypoints
Or provide the URL of data on the Web:
Draw the map
Open in new window
Reset the form
General map parameters
show advanced options [+]
Output format: Google Maps
Width: 700 pixels Height: auto
Margin: 45 Title:
Background map: Google hybrid (streets+satellite)
Data point options
show advanced options [+]
Colorize using this field: custom field Min: Max:
Custom colorization field: CPN
Colorization legend: None Legend steps: 1
Lightness: 80% Saturation: 100%
Spectrum direction: up Hue 1: 0° Hue 2: 150°
Color of values beyond min. or max.: Min./max. color continues
Resize using this field: None (don't resize points)
Custom resizing field:
Minimum radius: 5 pixels Maximum radius: 6 pixels
Unresized radius: 5 pixels Single-point map width: 10 km
Calculate frequency: No (creates a field called "N")
Show point names: Yes Show point descriptions: Yes
Default marker color: red
Google Maps options
show more Google options [+]
Generate marker list: No Width: px
Default icon: small circles
Google Earth options
show more Google Earth options [+]
Default icon: Small circle
Contact information

Here you can play with the settings to see the different maps you can get. And the result may look like:

By default SD Logger writes GPS data once per minute that great for walking with Geiger Counter. If you drive or fly, you may need faster logging. In this case please modify the sketch by yourself for saving LOG.TXT file with different time periods.

How to work with LOG.CSV file:

The file contains CPM readings points for every 10 seconds. You can view it through any csv file editor or with our "Radiation Logger" software. Press Graphs→ Graph from log file and point to your LOG.CSV file "Radiation Logger" will build a graph with your saved data.

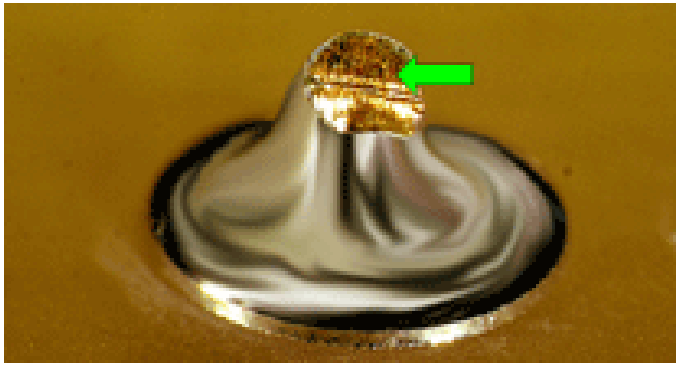
TIPS:

- Make sure the static strap is tight across your wrist at all times.
- DO NOT linger on parts with the soldering iron.
- As a general rule use a 5 second linger time with a 10-20 second cool time for parts.
- Mount and solder components flush to the board unless otherwise stated.

TIPS:

- Use caution when clipping leads to avoid flinging metal across the room.
- All soldering must achieve a good solder filet on the pad as shown for circuit reliability.
- Also clip the leads in this fashion.
- Bend resistors and diodes using your plastic tool as shown.

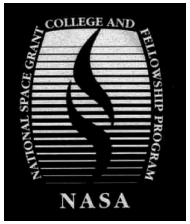
workmanship.
nasa.gov

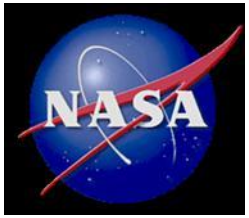


Example of a good solder filet

Let's Begin!

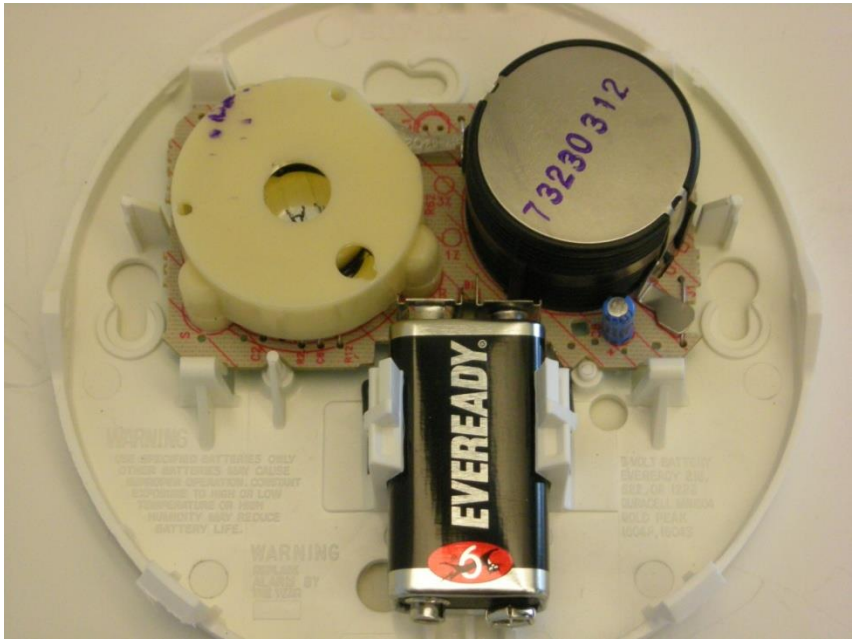
NEW
MEXICO
SPACE
GRANT
NASA EPSCoR


NATIONAL SPACE GRANT COLLEGE AND FELLOWSHIP PROGRAM
NASA


NASA

Step 1: Opening the detector housing

Opening the detector housing and remove the lid.



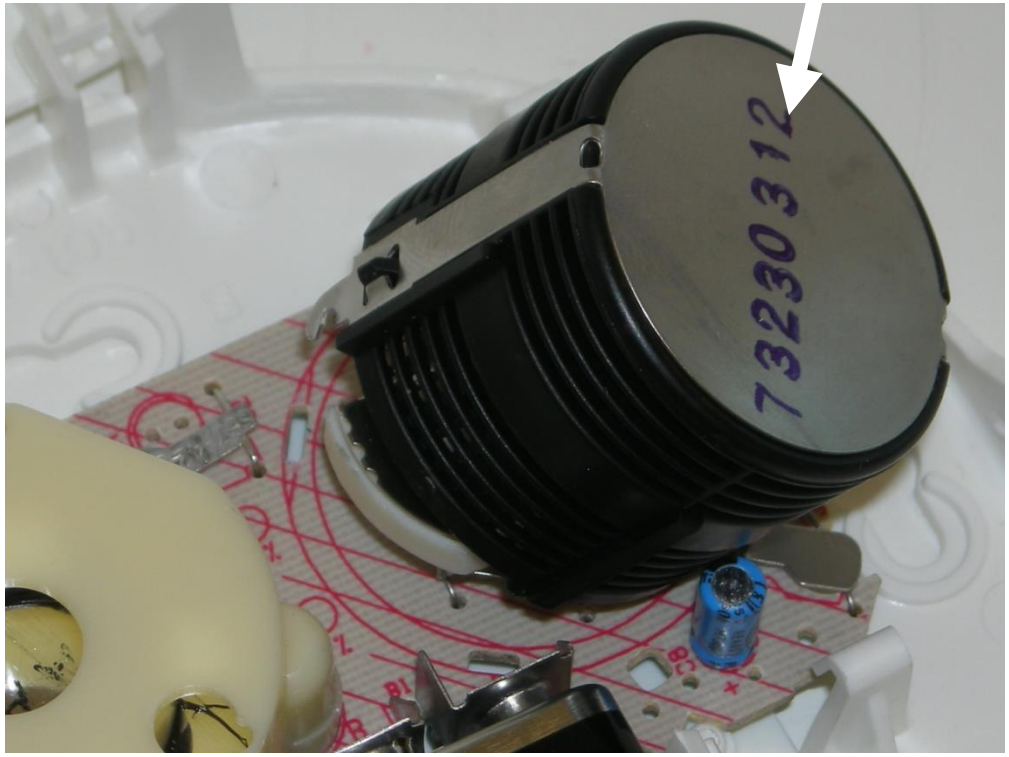
Step 2: Visually inspect the detector

Speaker

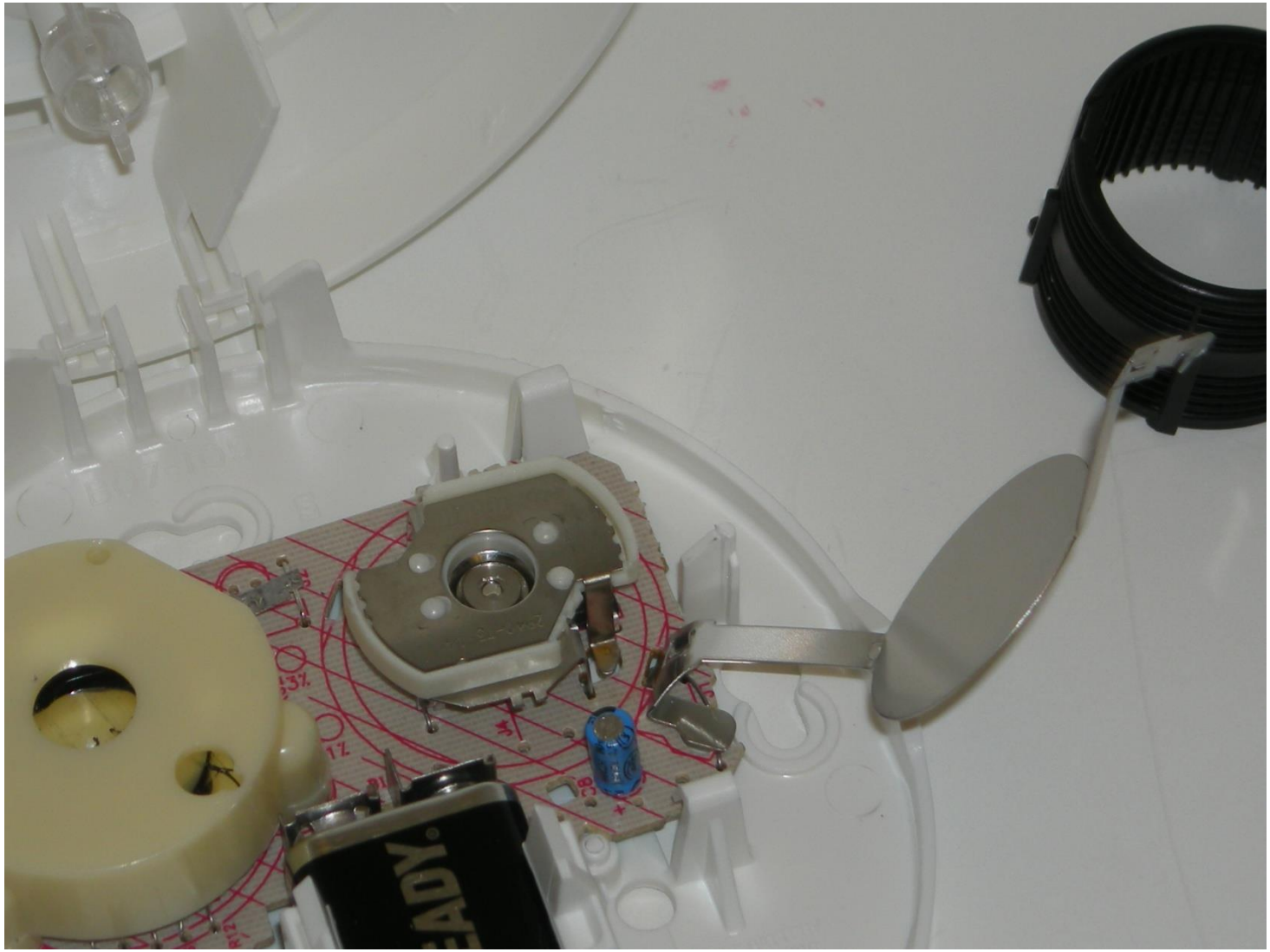
Radiation Source

Step 3: Peel back the Black cover over the Detector

Peel Back and remove

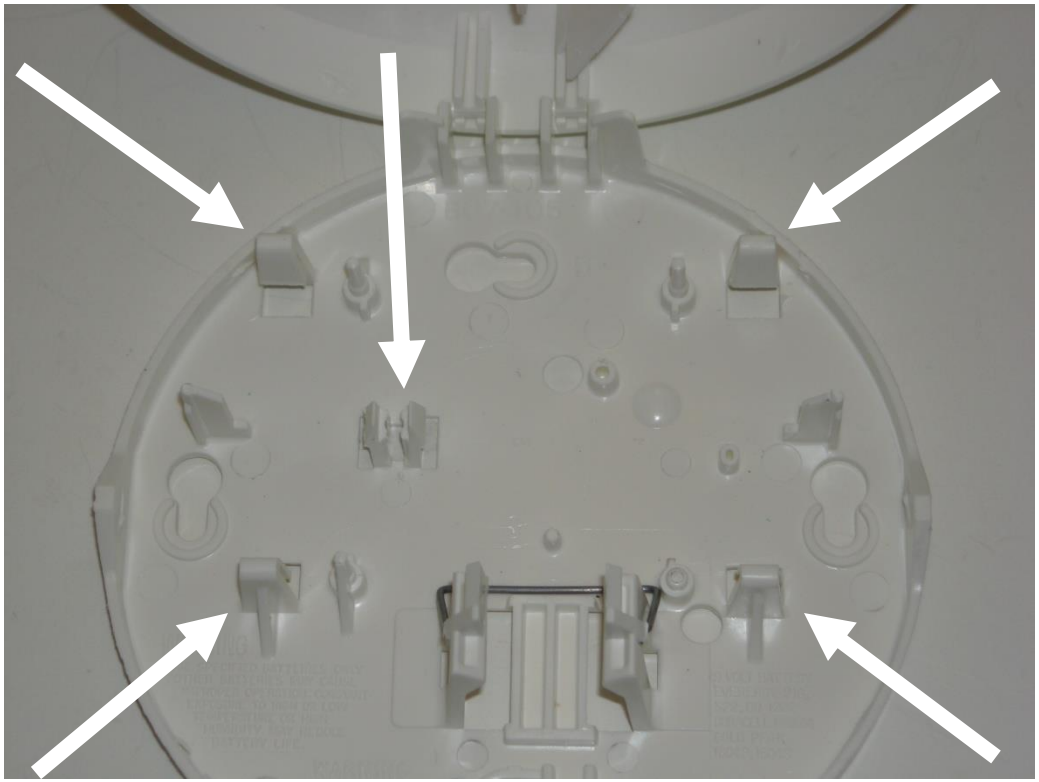


Step 3: Peel back the Black cover over the Detector

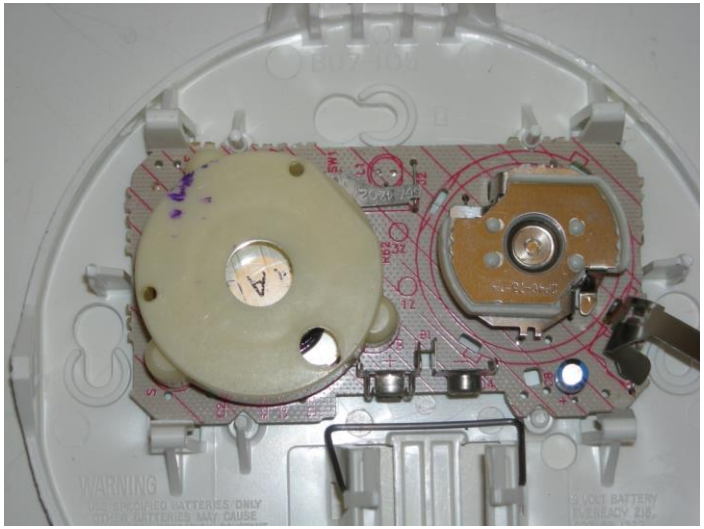


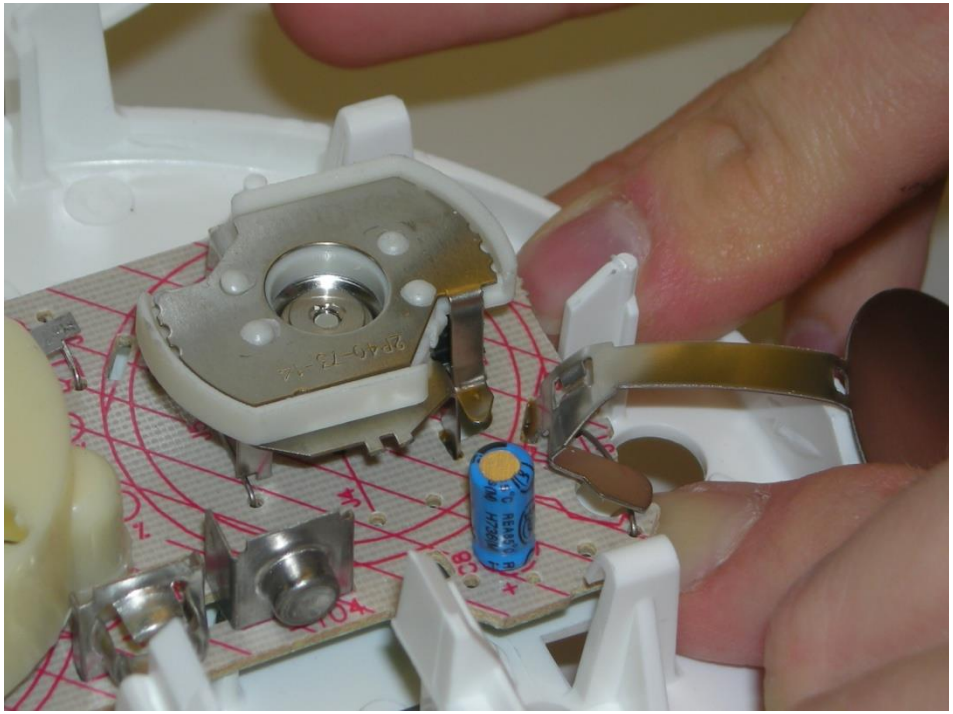
Step 4: Remove PCB

Remove the PCB from the protective housing by bending the four plastic prongs to release and pulling the PCB.



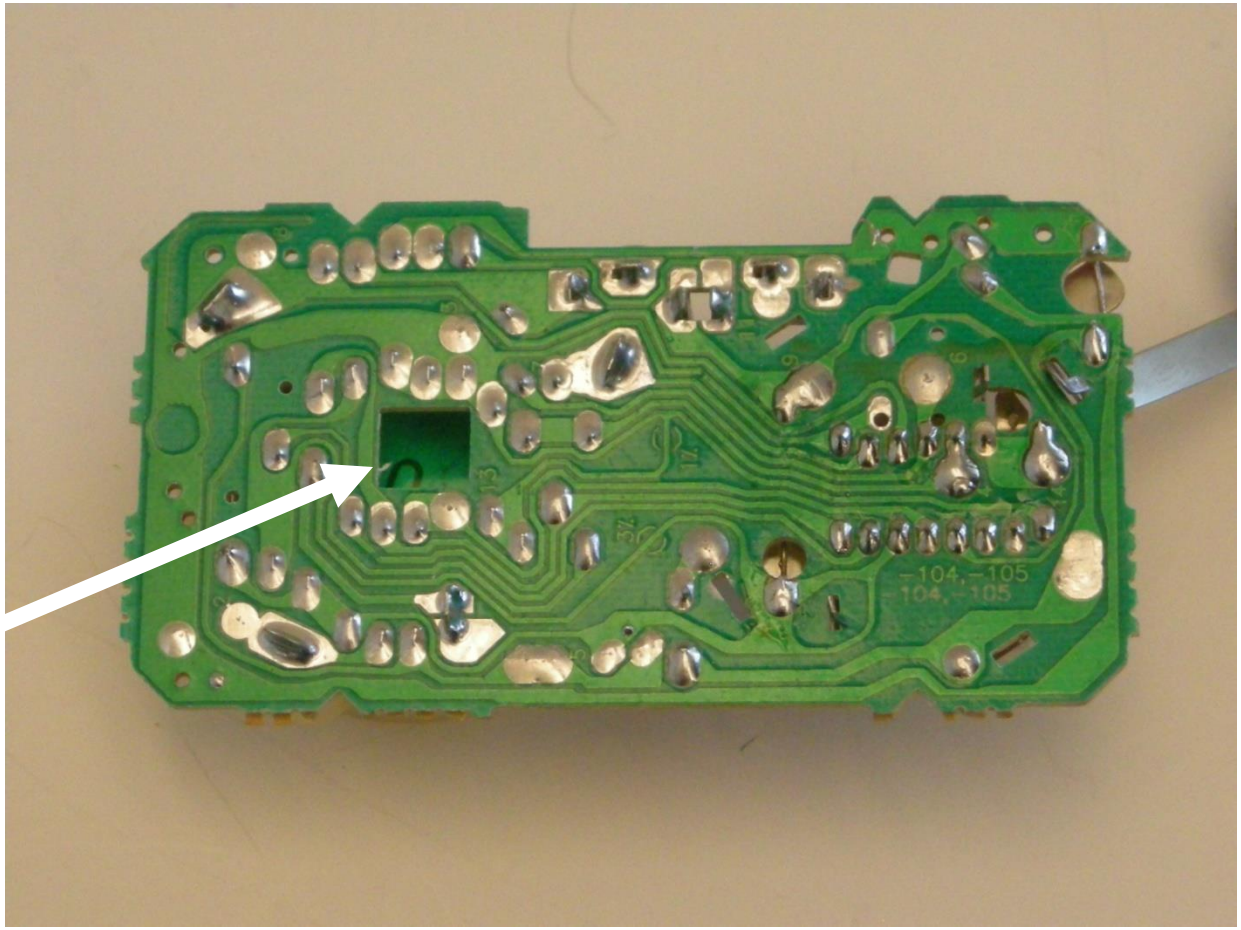
Step 4: Remove PCB





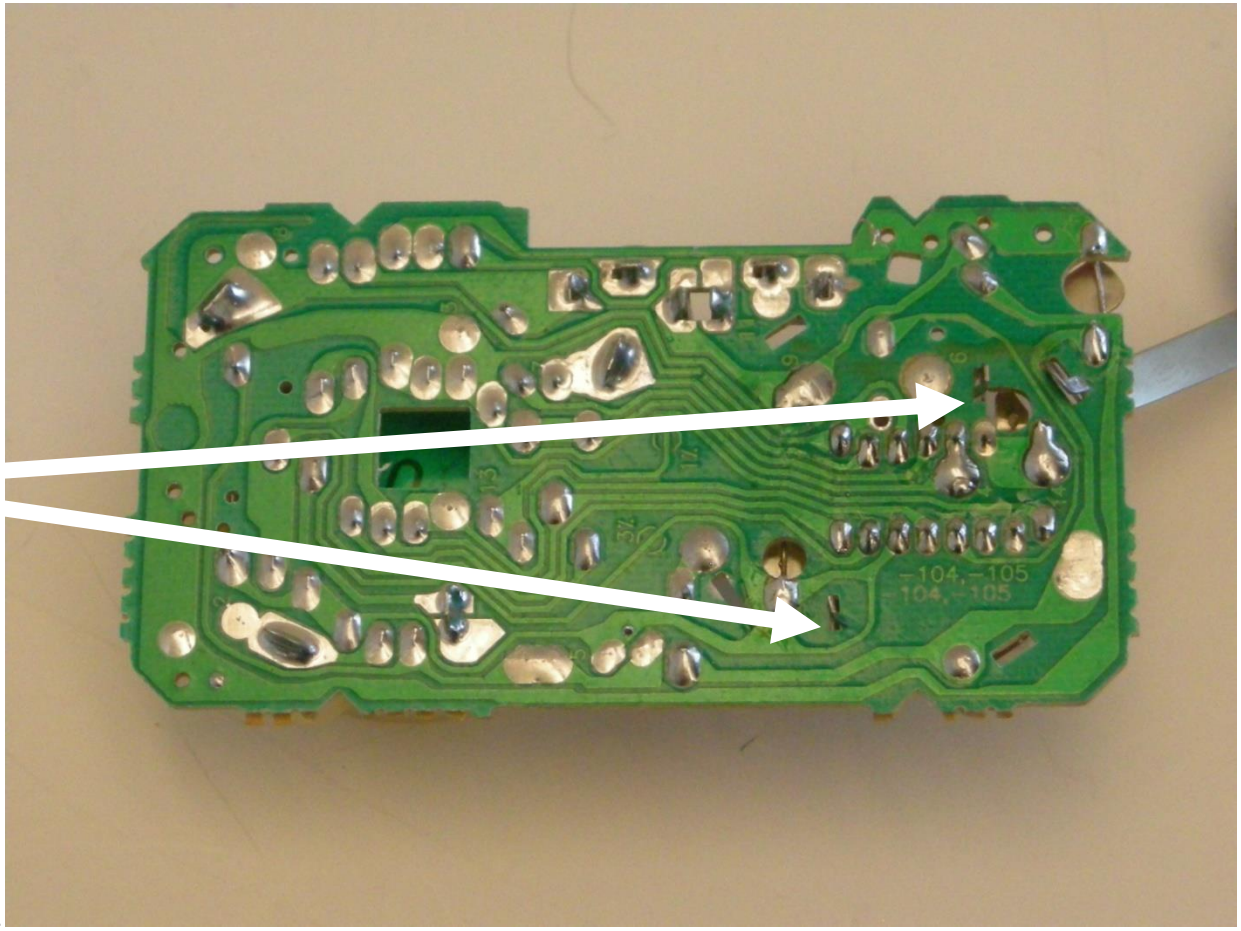
Step 4: Remove PCB

- **The PCB is glued to a middle prong. Pull until it releases from this prong, which may require a little additional force.**

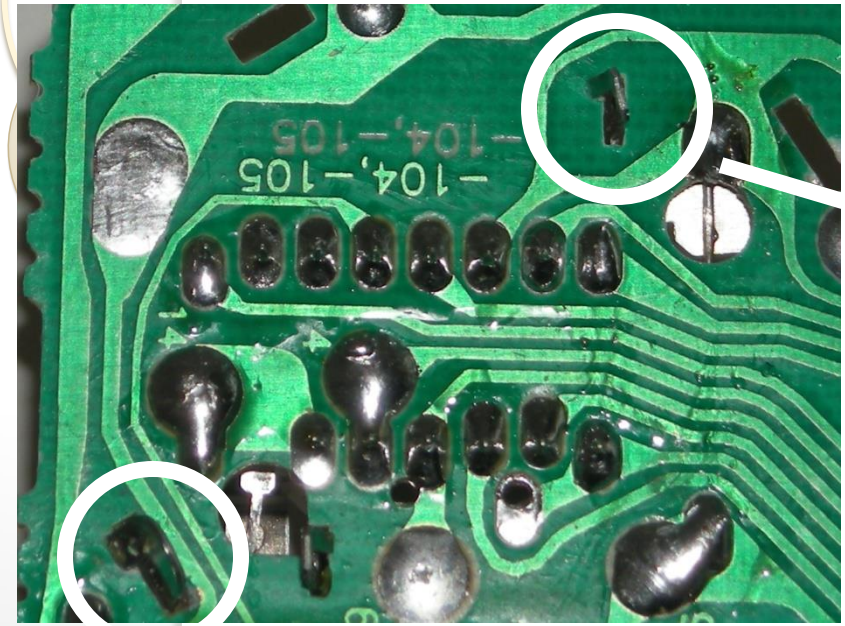


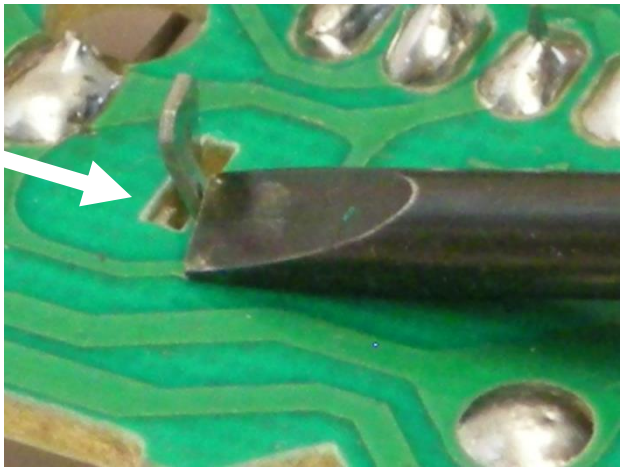
Step 5: Remove Radiation Source

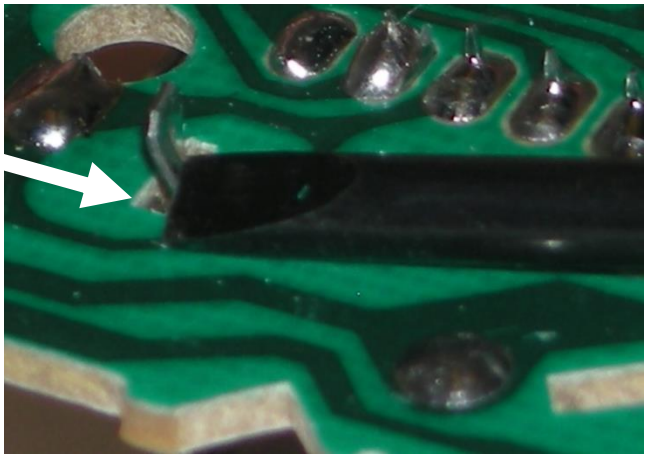
- **Note the two metal notches holding the radiation source to the PCB.**
- **Bend these with a provided screwdriver as shown so the source will slide out of the PCB.**



Step 5: Remove Radiation Source



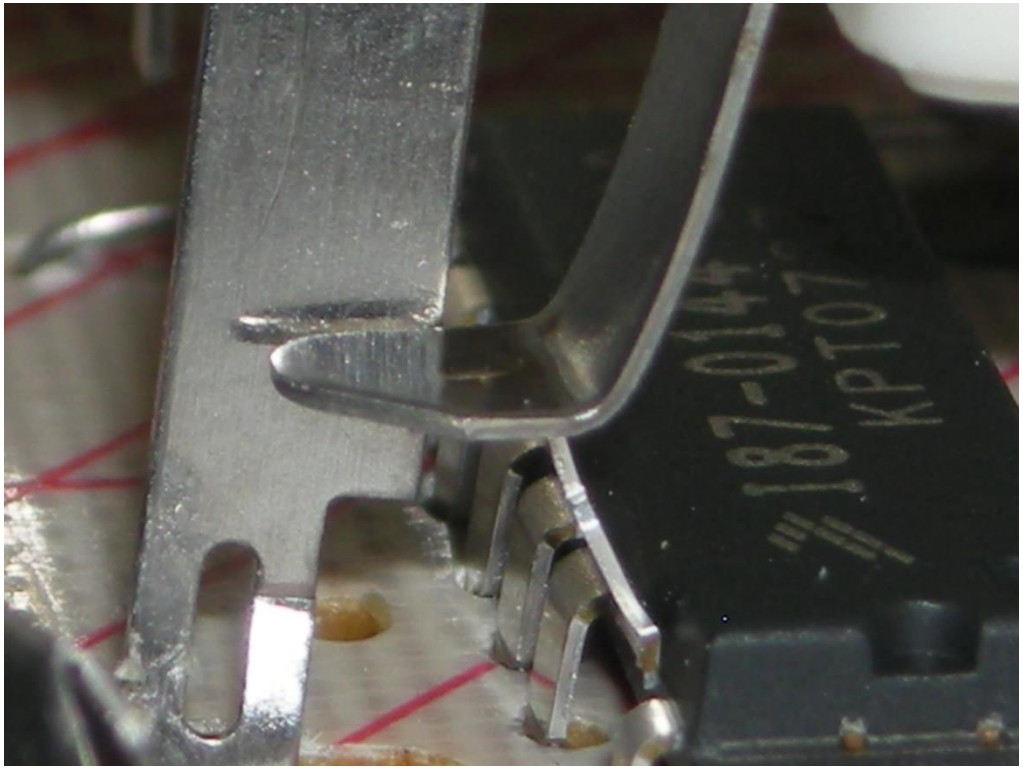




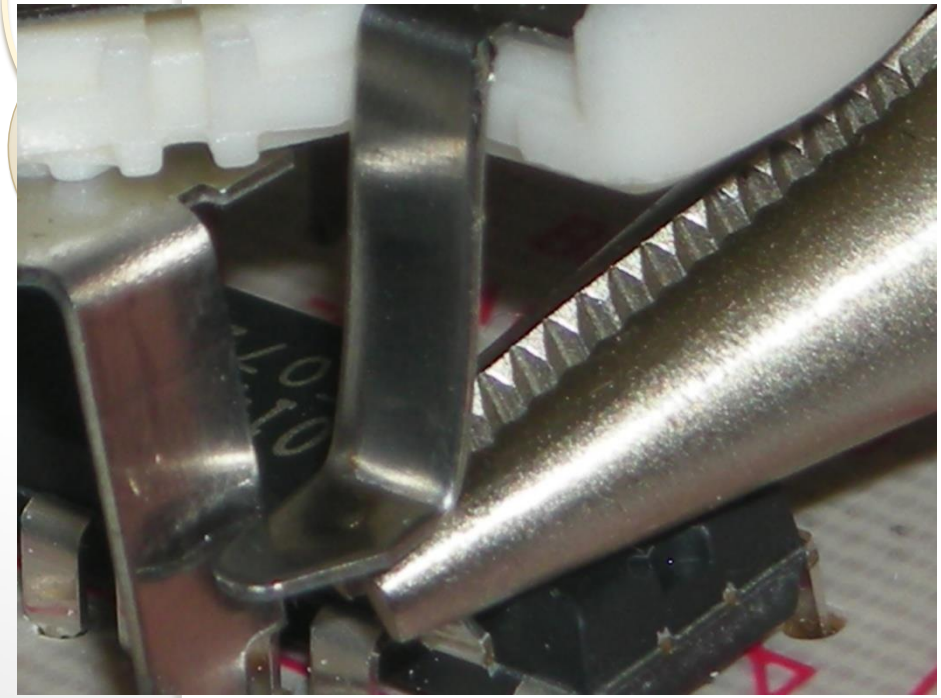
Step 6: Clipping attachments

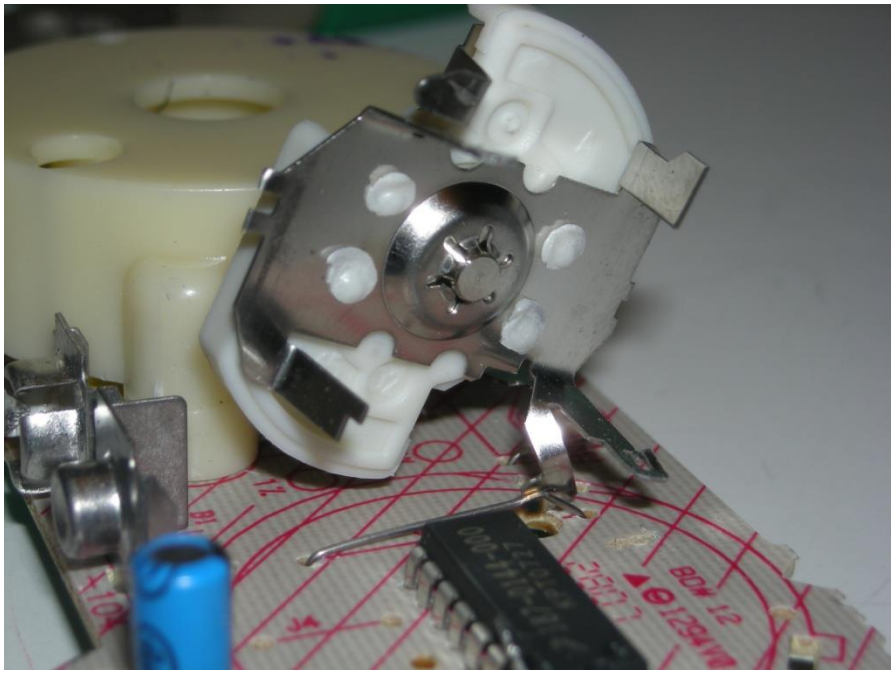
- Clip the attachments on the radiation source with the pliers until the source is free.

Use brute force to extract the source, and don't worry about damaging the remainder of the detector as it is not needed.

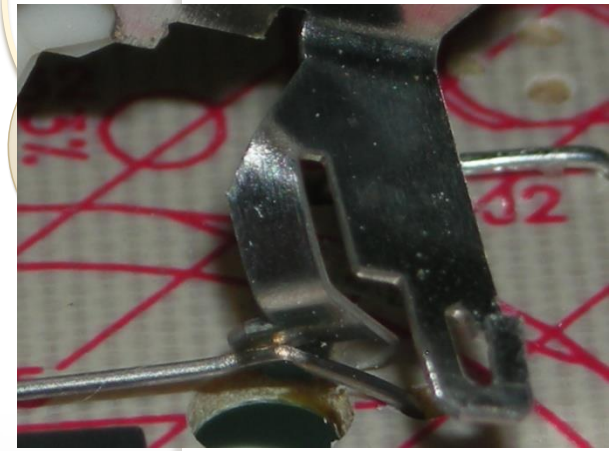


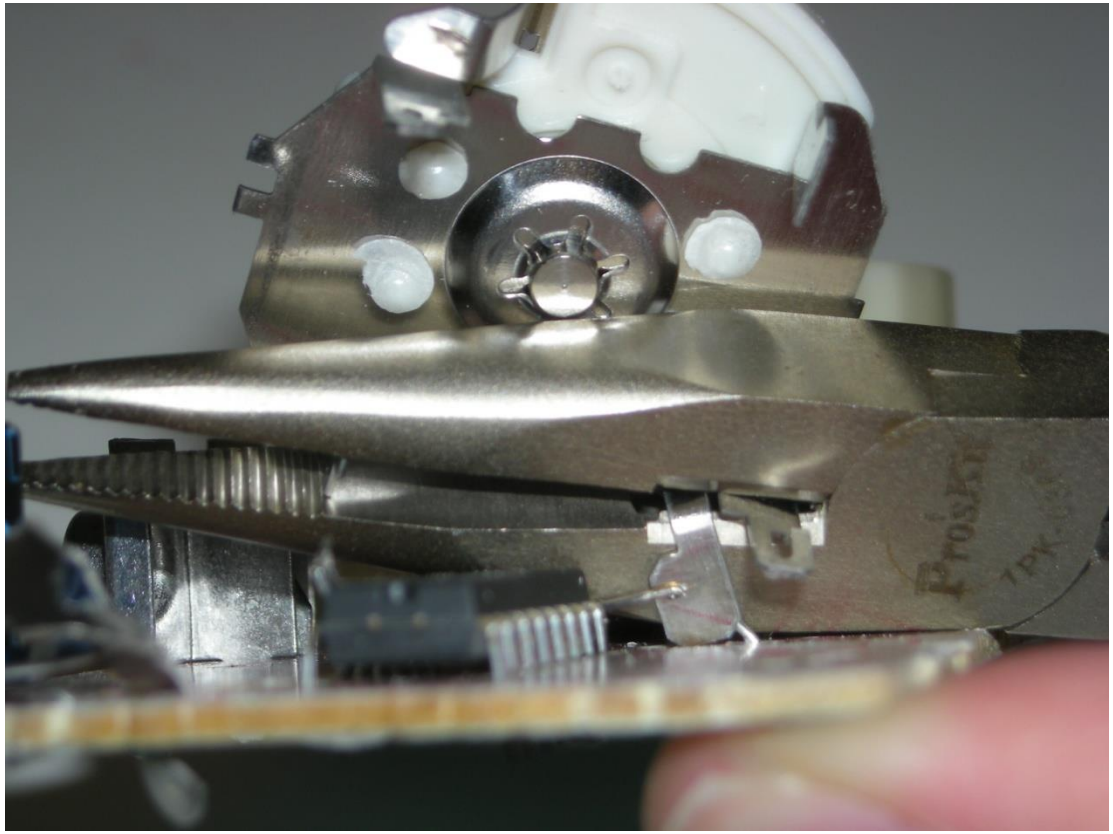
Step 6: Clipping attachments



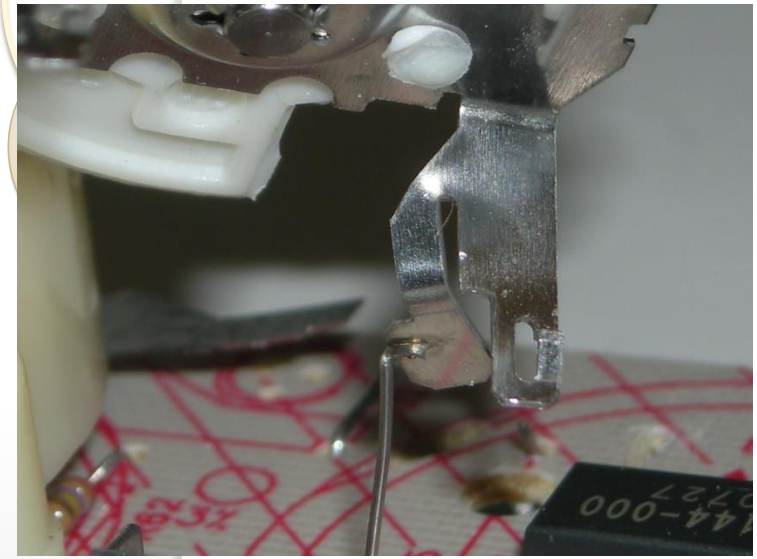


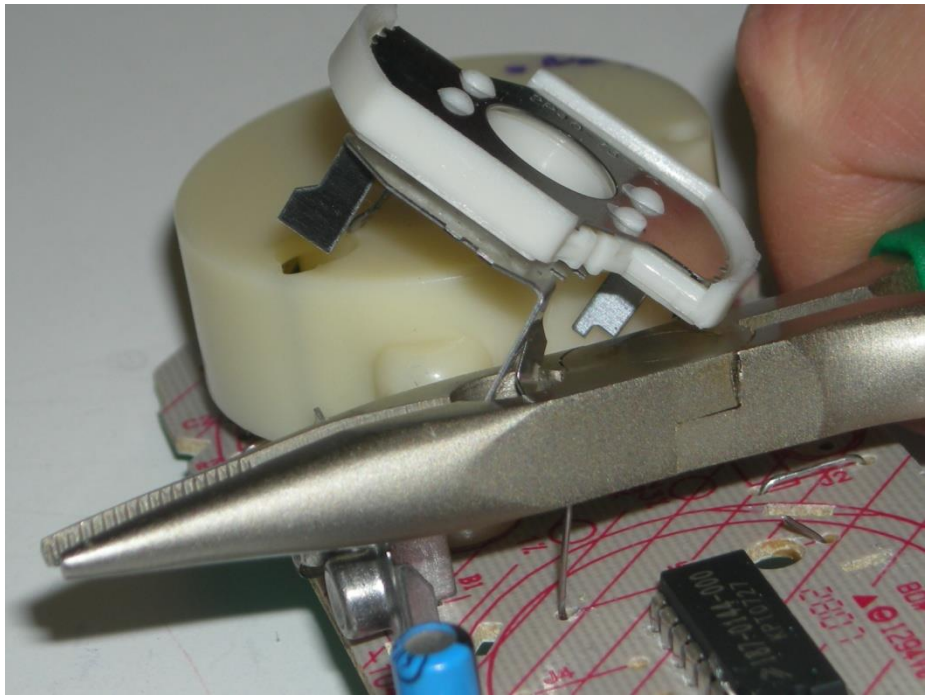
Step 6: Clipping attachments



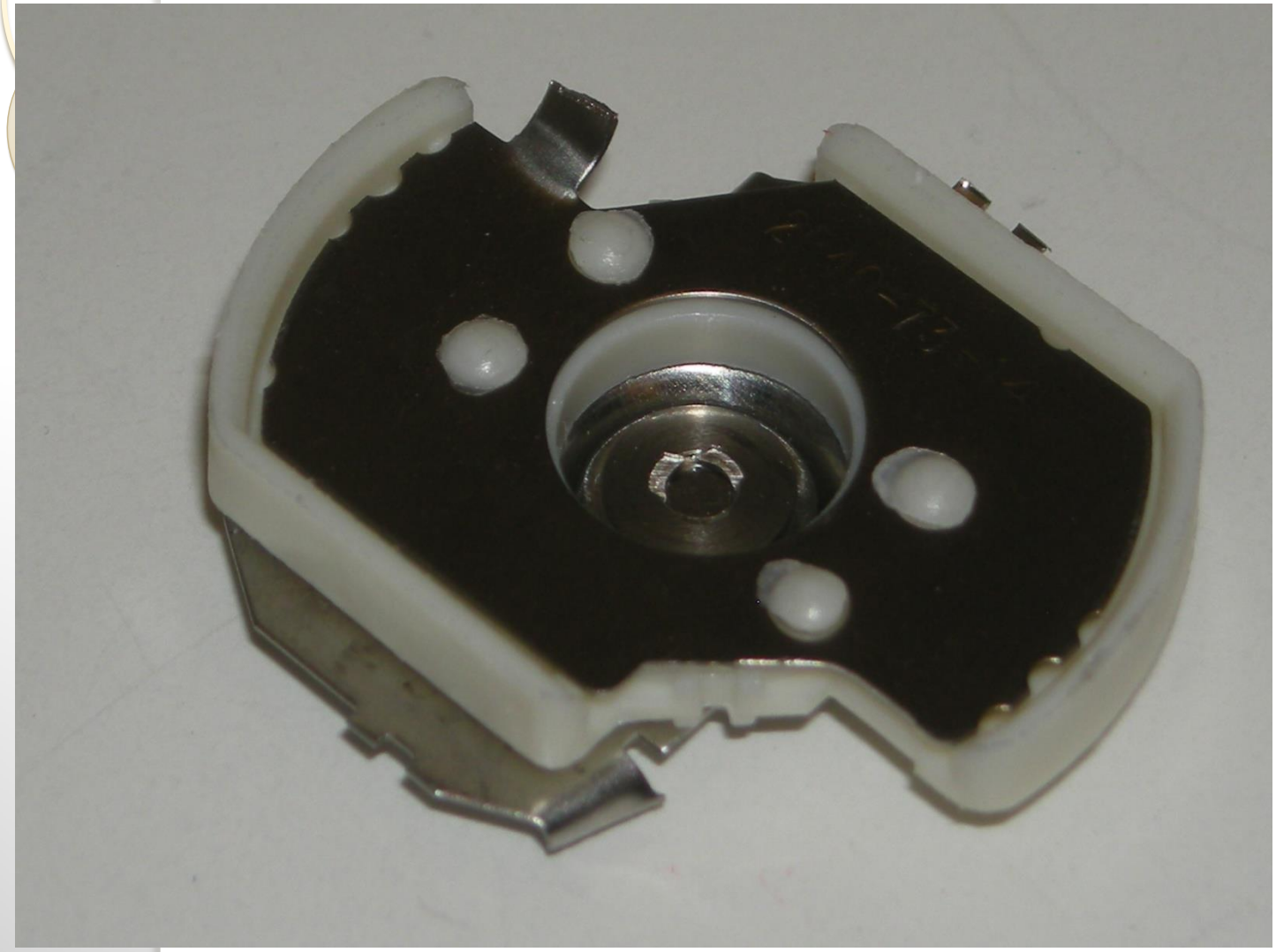


Step 6: Clipping attachments





Step 7: The source is ready

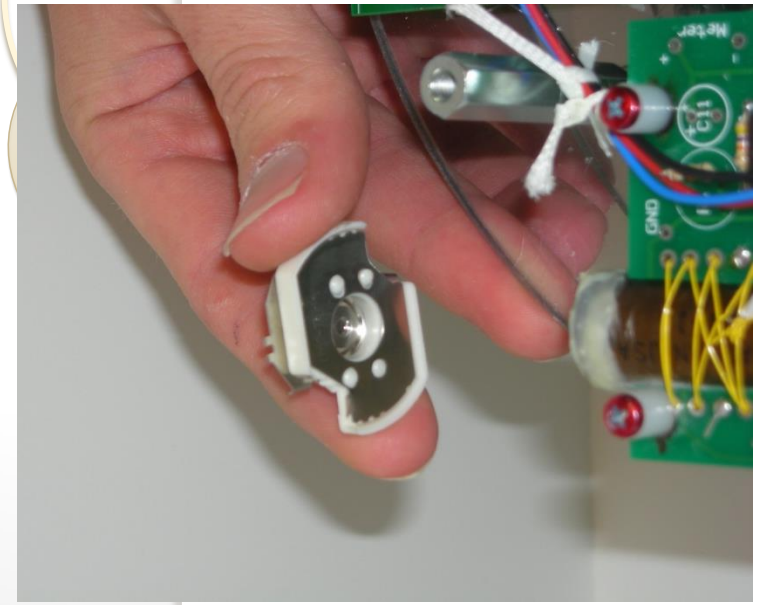


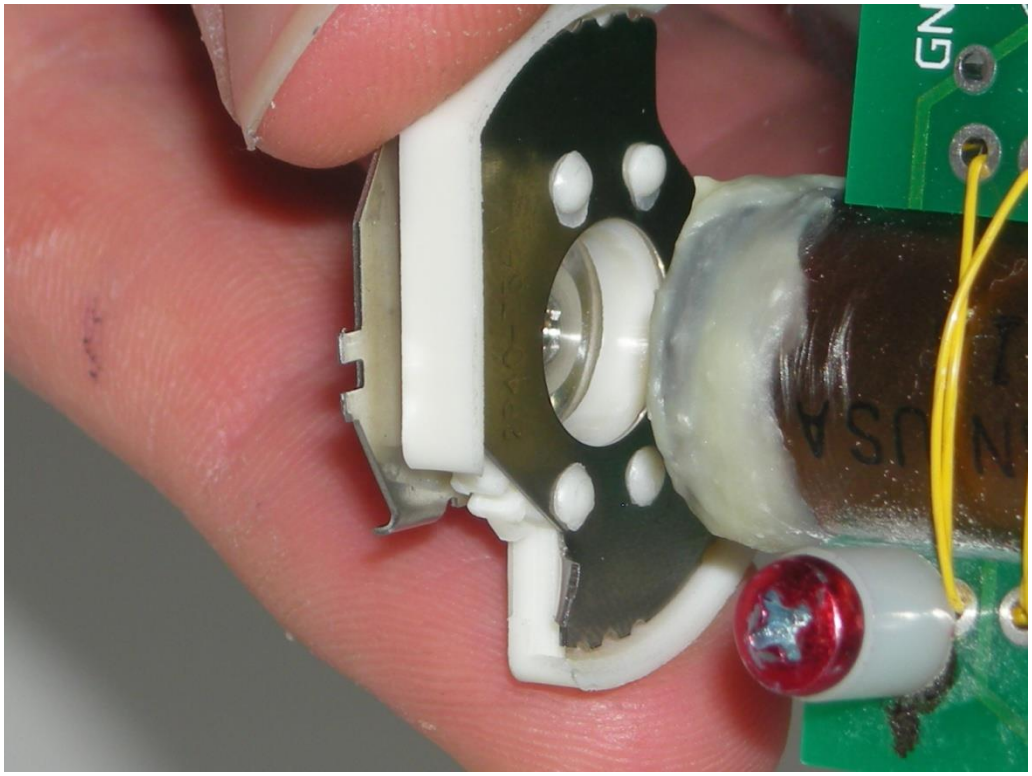
Final Product: Testing

Final Product Testing

- Attach power to the circuit again.
- The Geiger counter should randomly blink detecting usually 12-14 counts per minute depending on sources in the area and shielding.
- Acquire the provided alpha particle source (taken from a smoke detector).
- Notice a large jump in the frequency of counts.
- Each count represents the detection of a radioactive particle by the Geiger counter.

Final Product Testing





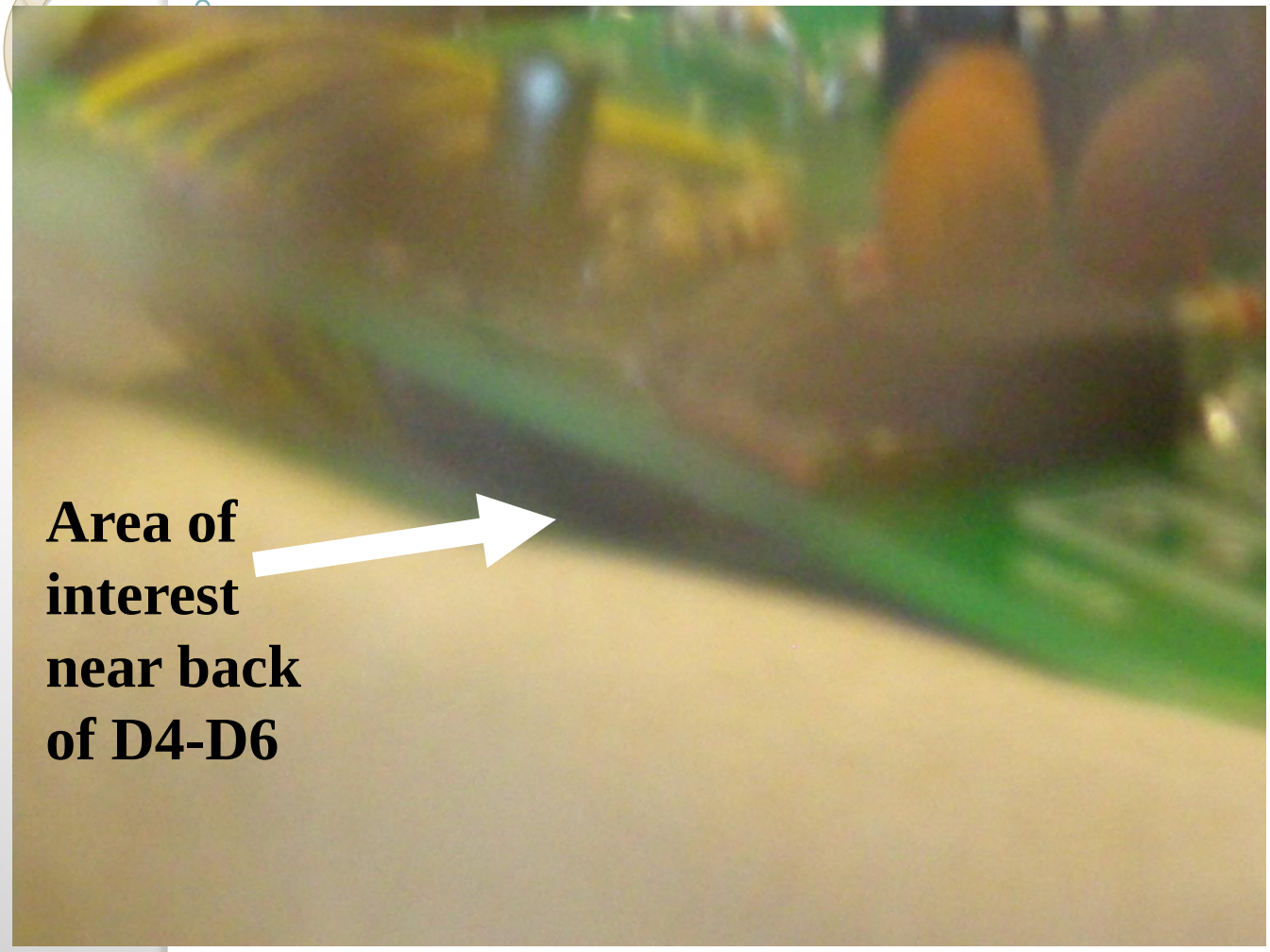
Coronal Discharge

Coronal Discharge: An Overview

- Coronal discharge occurs in low pressure environments with high voltages present.
- The air around a high potential (high voltage) will become a conductor and emit a bluish glow (plasma).
- This plasma will cause adverse effects for the component as well as neighboring parts.
- The plasma is a bluish-purple and is visible under normal lighting. (see images)

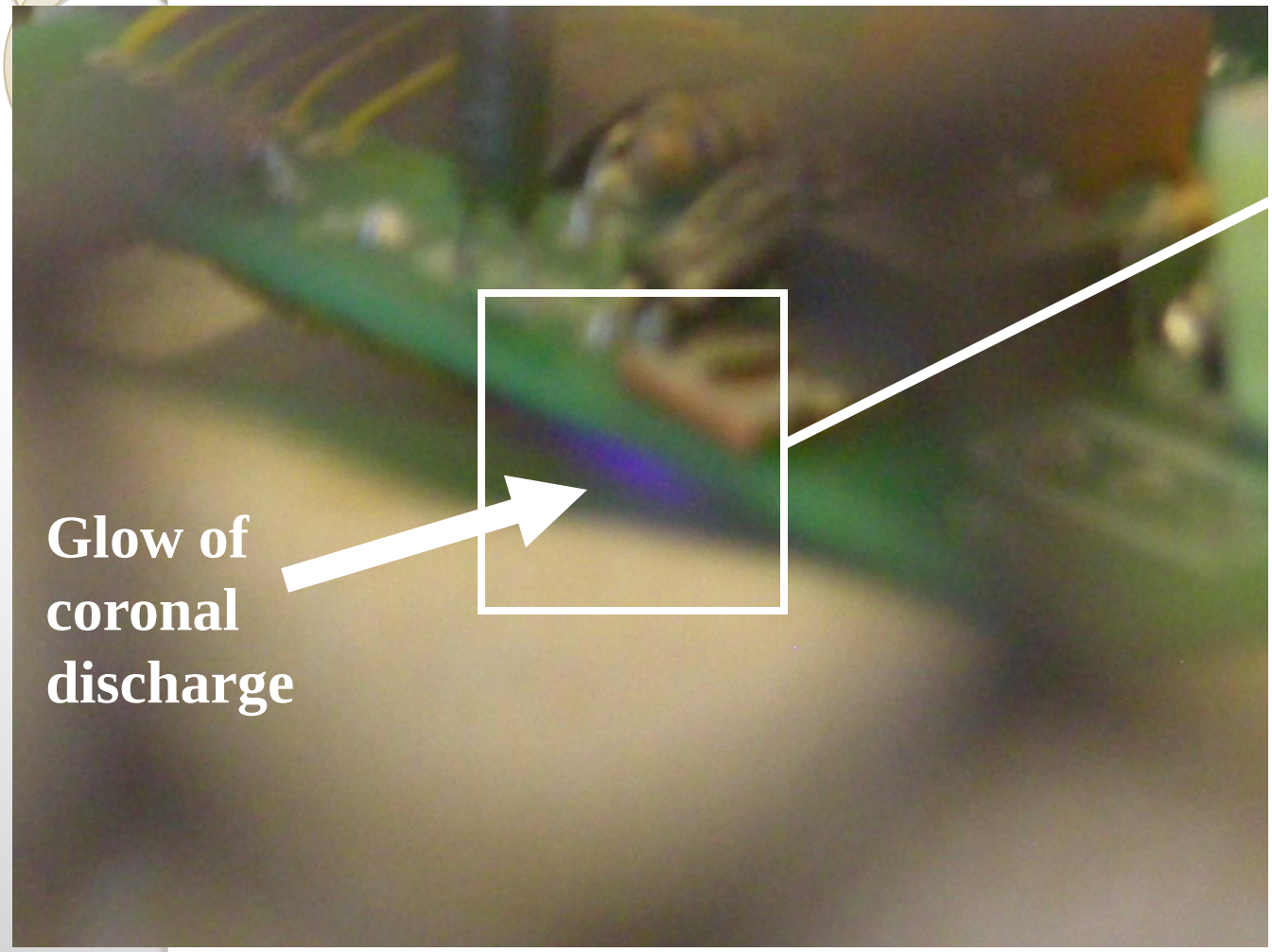
Coronal Discharge: An Example

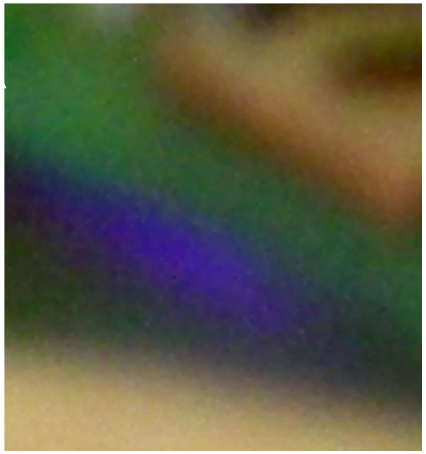
RockOn! Geiger counter seen through a vacuum chamber.



Coronal Discharge: An Example

Geiger counter seen through a vacuum chamber





Close-up

Coronal Discharge: The solution

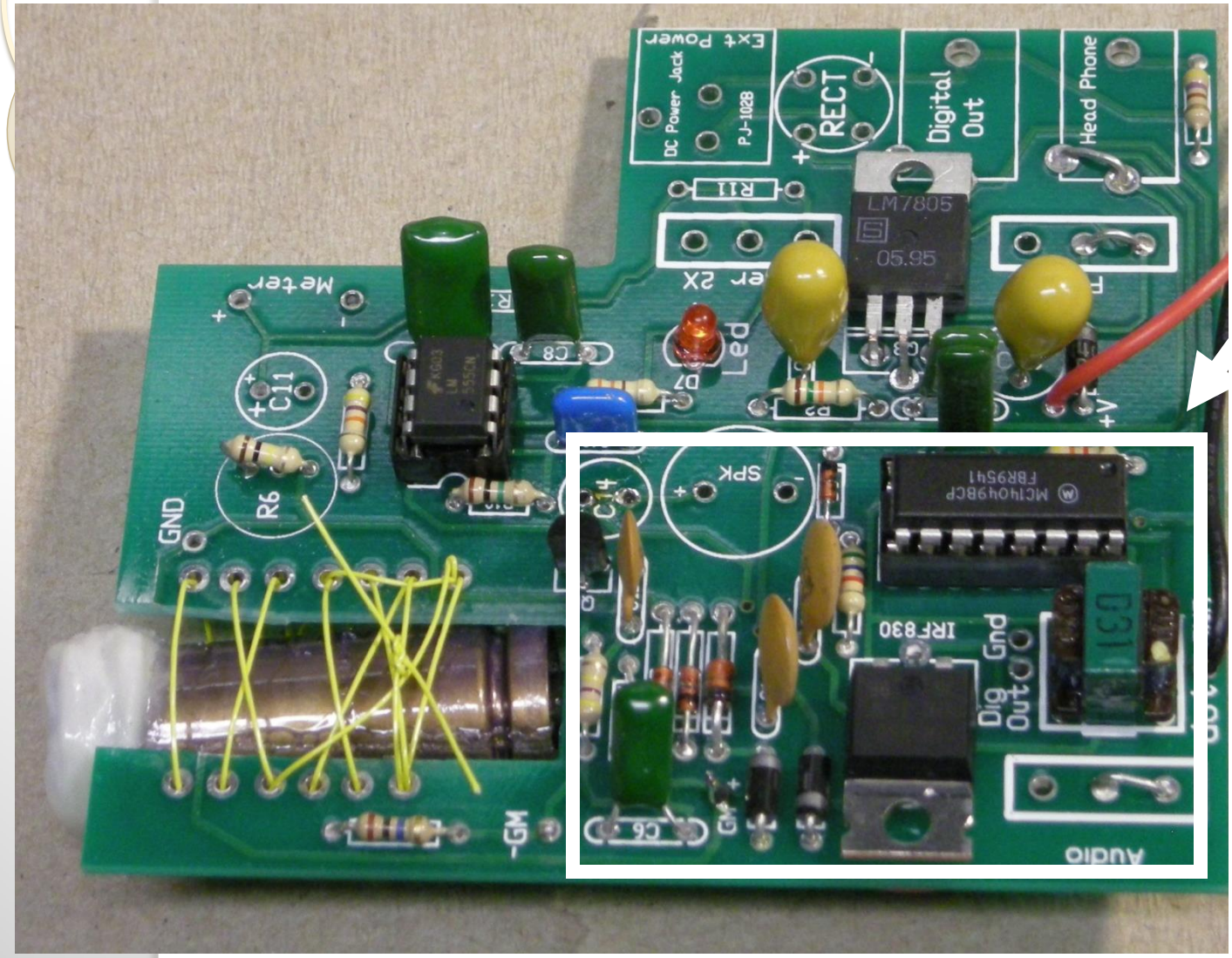
- Coronal discharge is detrimental to parts.
- Dangerous to other payloads on the rocket.
- To mitigate these risks, we will add conformal coating to the board to prevent coronal discharge.
- **Note: We will be in a pressurized environment on this flight so this is not necessary, but is a good practice especially with space applications.

Conformal Coating

Step 1: Board Prep

- Take the board to a well ventilated area (we will be outside).
- Put on safety glasses and rubber gloves.
- Place the board face up on the prepared protected surface.
- Shake the bottle lightly and open it.
- MAKE SURE there is no power on the board.

Step 1: Board Prep



HV Section

Step 2: Begin Coating

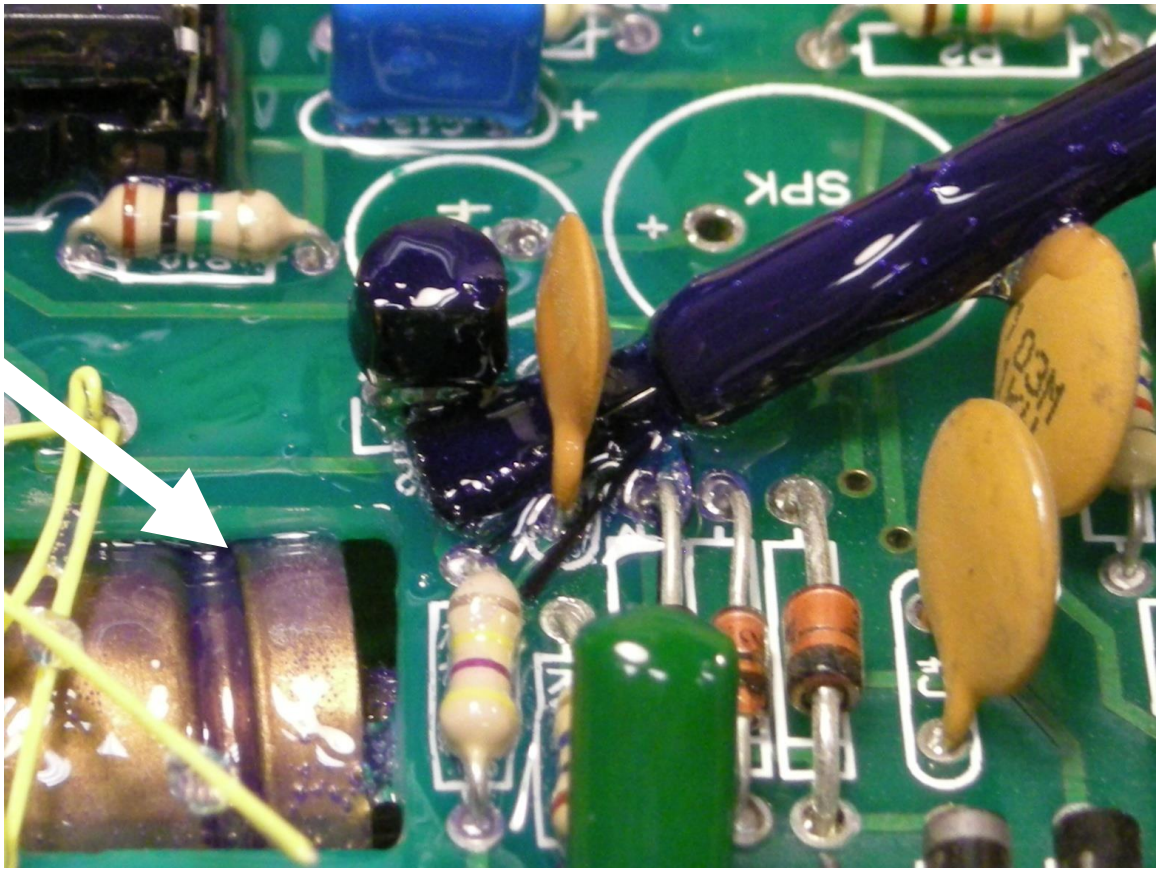
- Dip the brush in and begin application coating the entire top side of the board with an even layer.
- Re-dipping the brush every 2-3 strokes is recommended.
- The board should look glossy under lighting where coating has been applied.
- If any safety concerns occur consult the MSDS provided.

Step 3: Detail Coating (chips in sockets)

- Coat the chips as well as long as they are secured in their sockets.

Step 3: Detail Coating (underneath components)

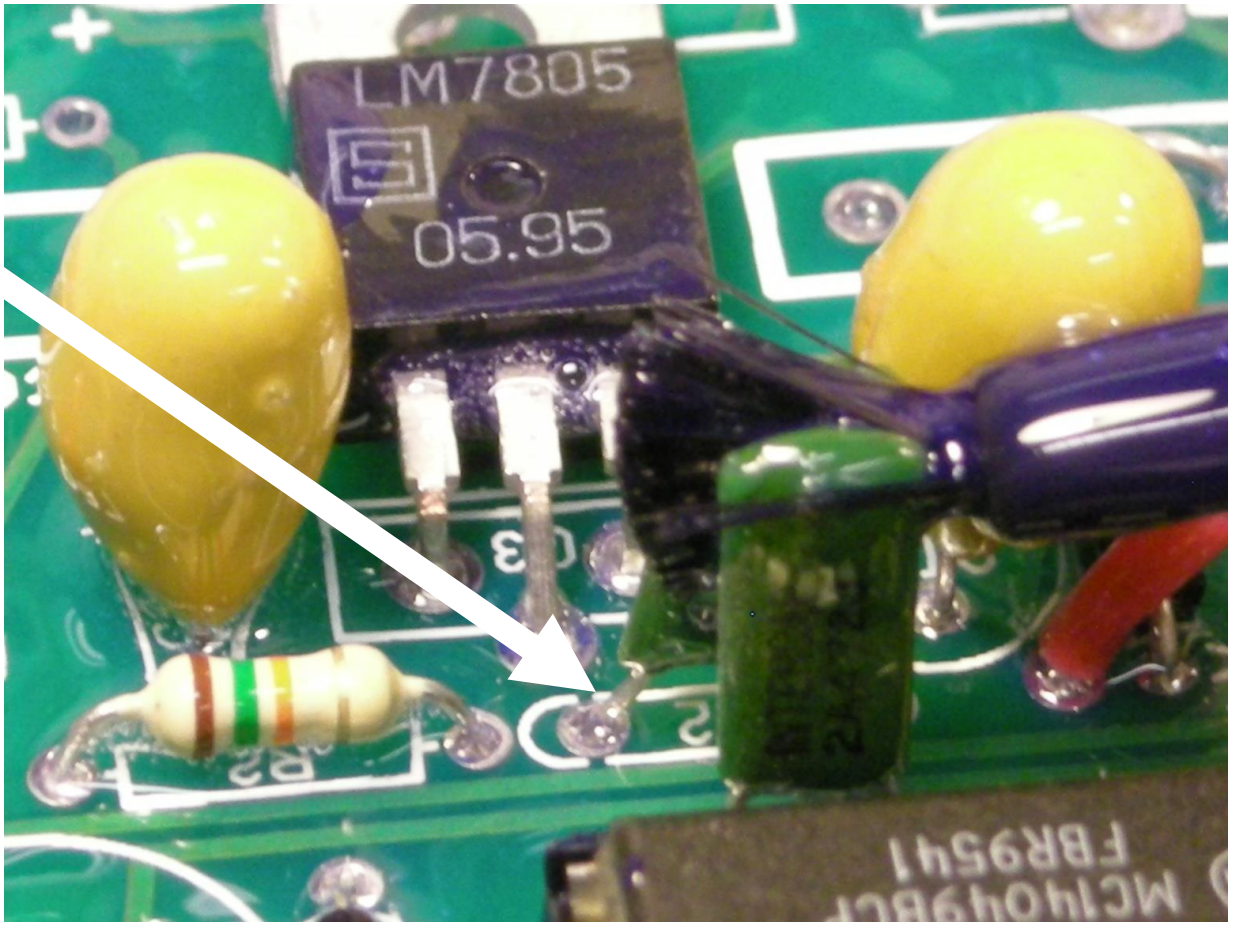
- **Apply underneath closely oriented parts like diodes, capacitors, and resistors in this manner.**



Step 4: Detail Coating (between components)

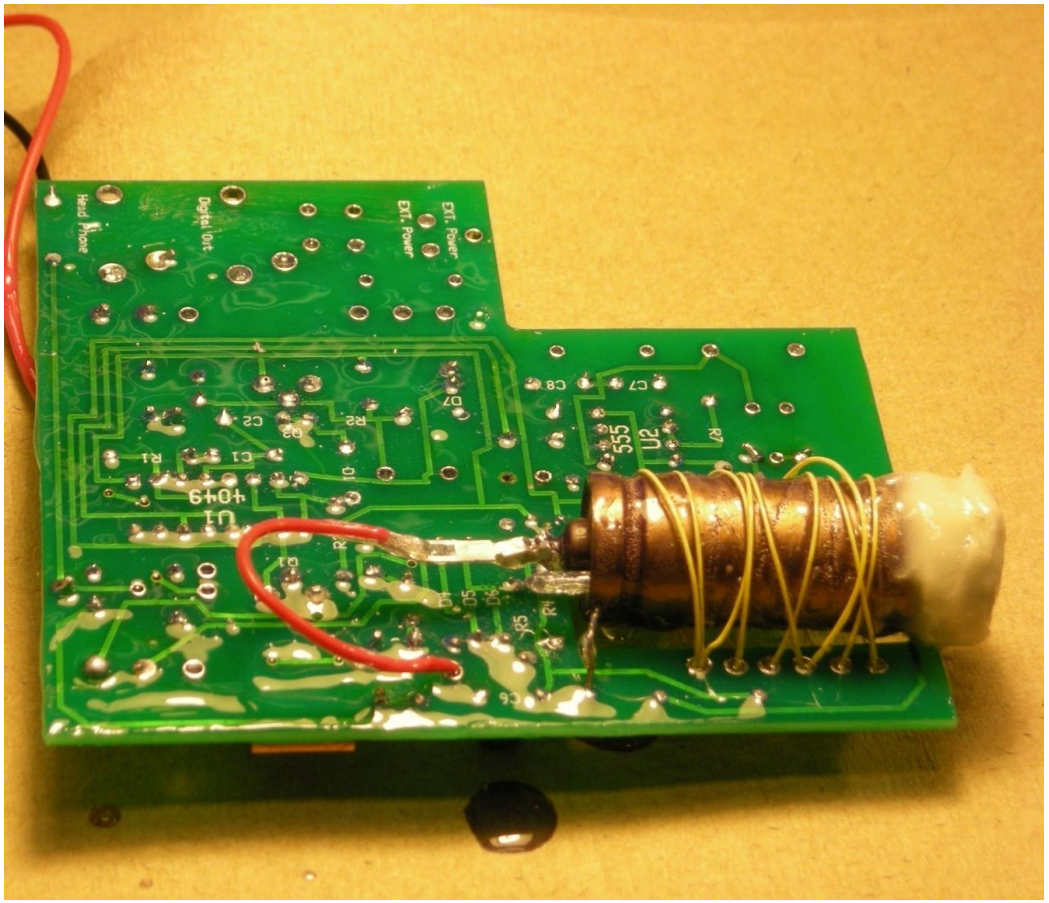
- Apply between closely oriented parts

Use smooth strokes (about 3 per dip)



Step 5: Backside Coating

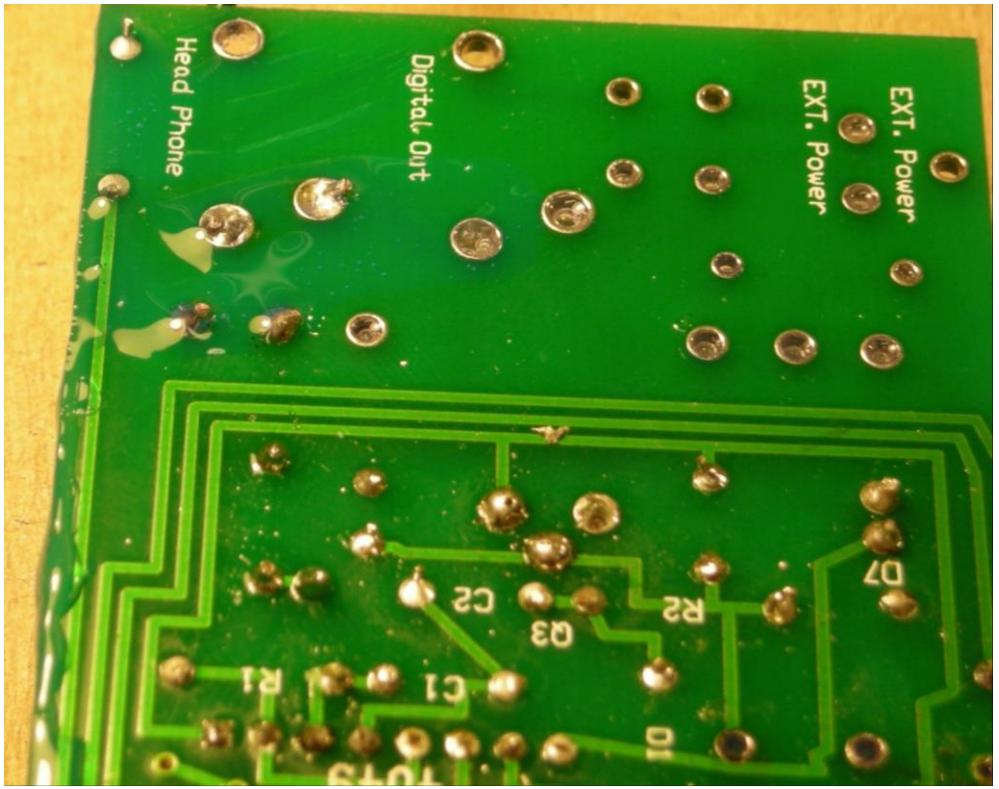
- Flip the board over using minimal contact with the currently curing coating.
- Coat the entire backside as desired using the same 3 stroke per dip rule.



Step 5: Backside Coating

Apply across the whole board, make sure the whole PCB is coated thoroughly.

Note glossy look of coated board.



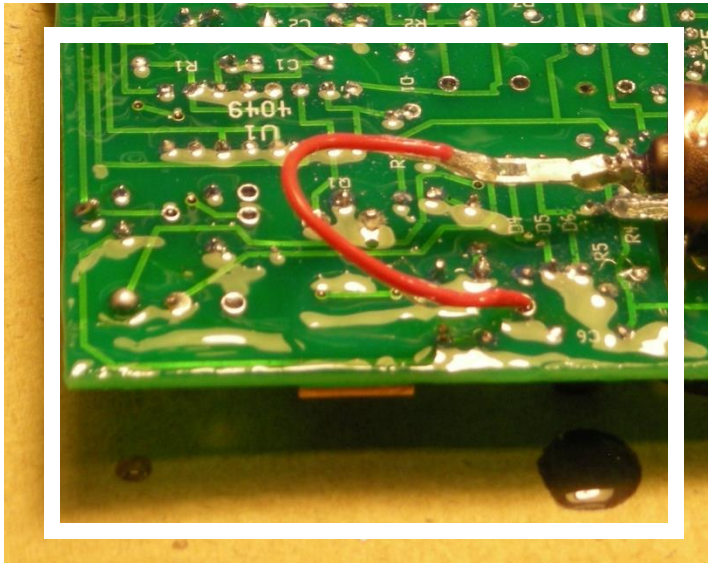
Step 6: Touch-ups

- Visually inspect the board to ensure it is coated thoroughly.

- Make any touch-ups as necessary, ensuring there are no bubbles underneath parts.

- You may add additional coating to the HV section if you desire, but one coat is enough to do the job.

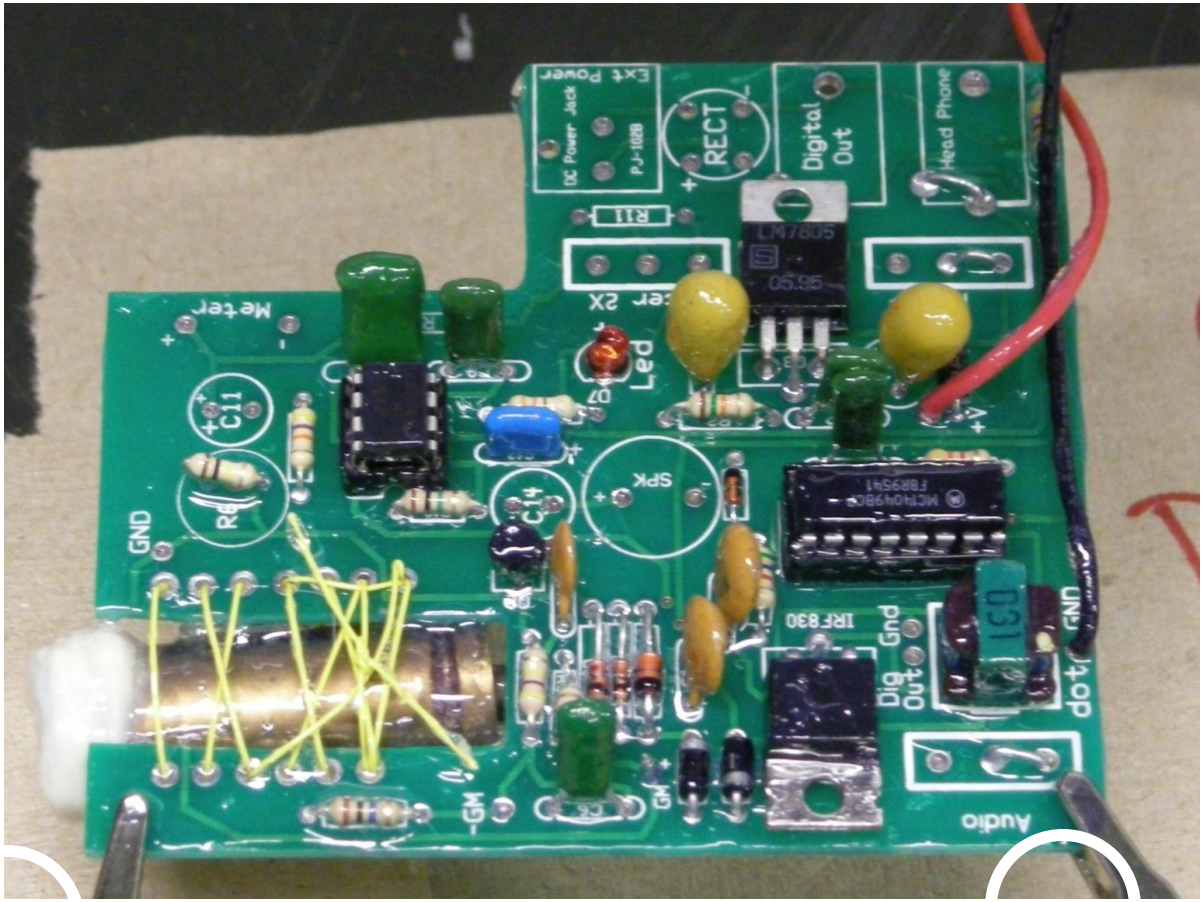
HV Section



Step 7: Drying and Clamping

- Flip the board over and attach to helping hands where shown.

- This area is not HV and won't affect the cure if clamped here



Step 7: Drying and Clamping

- Allow the board to cure in a controlled environment for 24 hrs to achieve a full cure.
- Tack free cure is about 10 min. The coating wont stick to your hand as readily after this stage.
- Handling cure is about 4-6 hrs depending on the humidity.
- Cure time can be decreased by using a convection heater at low heat (100 °F) and low humidity.